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SPFD BRANCH
REGION VII

Site: West Lake Landfill
ID #: MOD079900932
Break: 10.9
Other: workplan
8-5-94

0714

August 15, 1994

Mr. Steve Kinser
Environmental Engineer
Waste Management Division
United States Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

SUBMITTAL OF FINAL REVISED TEXT AND RESPONSES TO USEPA COMMENTS TO REVISED RI/FS WORK PLAN FOR THE WEST LAKE SITE, BRIDGETON, MISSOURI

Dear Mr. Kinser:

Enclosed please find three copies of the revised text pages for the RI/FS Work Plan, West Lake Landfill Areas 1 and 2, Bridgeton, Missouri. The text has been revised consistent with the review comments dated June 30, 1994. These comments were also discussed during a meeting on July 13, 1994. In making some of the requested changes, the pages following the change have been effected. Where this has occurred, we are forwarding copies of all of the pages that have been effected.

The following pages of text and tables are included with this transmittal.

<u>Workplan</u>
Table of Contents
Section 1.0 (all text in Section)
Section 3.0 (all text in Section)
Section 4.0 (all text in Section)
Section 5.0 (all text in Section)
Section 6.0 (all text in Section)
Section 7.0 (page 7-52 only)
Table 4.2, 4.3, 5.1, 5.3, 5.4 & 6-1

<u>Sampling and Analysis Plan</u>
Table of Contents
Sections 1.0 through 5.0 (entire Sampling Plan)

Enclosed also please find detailed responses to your review comments, and the review comments from the Missouri Department of Natural Resources (MDNR). Each of the specific comments are reproduced in entirety along with a summary of the revisions made in response to the comments.

We look forward to your final approval of the Work Plan and starting work on the RI/FS. Please call if you have any further questions or comments.

Sincerely,

Robert A. Little for

Stephen Ripple
Chief Health Scientist

William H. Baker for

Bruce E. Ehleringer
Managing Principal Hydrogeologist

Enclosure

cc: Rob Lowy, Los Alamos Technical Associates
Doug Borro, Laidlaw Waste Systems (Bridgeton), Inc.
William E. Whitaker, Rock Road Industries, Inc.
Rich Ziegler, Cotter Corporation (N.S.L.)
James W. Wagoner, United States Department of Energy

bcc: Mike Hockley/Jerry Wolfe
James Gunn/Bill Werner
Charlotte Neitzel
Angela Foster

10.9

Site: West Lake Landfill
ID#: MOD 079900932
Break: 10.9
Other: WK1
9-2-93

McLaren Hart™

September 2, 1993

Ms. Diane L. Newman
Environmental Engineer
Waste Management Division
United States Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

RE: REVISED WEST LAKE LANDFILL RI/FS WORK PLAN - September 2, 1993 SUBMISSION

Dear Ms Newman:

This letter is to transmit the referenced document to U.S. Environmental Protection Agency (USEPA), in accordance with the terms of the Administrative Order On Consent (AOC) For Remedial Investigation/Feasibility Study for the West Lake Landfill NPL Site as modified by the letter dated August 27, 1993 from David Hoefer to Michael Hockley. This Revised West Lake Landfill RI/FS Work Plan, which includes the Health And Safety Plan and the Sampling And Analysis Plan, is being submitted by McLaren/Hart Environmental Engineering Corporation on behalf of the Respondents under the AOC. This document reflects changes pursuant to the comments of USEPA, received by the Respondents on July 13, 1993, and as discussed with USEPA during meetings on July 28 and August 19, and during telephone conversations on August 24, August 26, August 30, and August 31, 1993.

Also find enclosed written responses to USEPA comments. This document is provided in supplement to the required Revised Work Plan and is intended to help highlight and interpret changes made in the Revised Work Plan.

The Respondents respectfully submit this Work Plan. We request the opportunity to discuss any questions or comments EPA may have during your review of this document.

Sincerely,

McLAREN/HART ENVIRONMENTAL ENGINEERING CORPORATION

Ray Forrester
Vice President
Director Central U.S. Operations

cc: Mr. Miles Stotts, Laidlaw Waste Systems (Bridgeton), Inc.
William E. Whitaker, Rock Road Industries, Inc.
Mr. Rich Ziegler, Cotter Corporation (N.S.L.)
Mr. James W. Wagoner, United States Department of Energy

The Hammons Tower, 901 St. Louis Street, Springfield, MO 65806 (417) 864-8811 FAX (417) 864-4887

RESPONSES TO
THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S
COMMENTS ON THE MAY 3, 1993, WEST LAKE WORK PLAN

September 2, 1993

Submitted as:

A Supplement to the
Revised (September 2, 1993)
West Lake Work Plan

Prepared for:

THE WEST LAKE RESPONDENT GROUP

Prepared by:

McLAREN/HART ENVIRONMENTAL ENGINEERING CORPORATION
The Hammons Tower
901 St. Louis Street
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ENVIRONMENTAL ENGINEERING CORPORATION

1. <u>Section 1.0. Page 1-1</u>

Comment: The last sentence of the first paragraph states that the AOC/SOW was executed by USEPA Regional Administrator. The text should be changed to state the AOC/SOW was executed by U.S. EPA Director, Waste Management Division.

Response: *The text has been revised to read "... the AOC/SOW was executed by USEPA Director, Waste Management Division, which initiated the RI/FS process."*

2. <u>Section 2.2.1. Pages 2-1 and 2-3</u>

Comment: a) The discussion of the site operational history appears unjustifiably limited in scope. The text on Page 2-1 should be expanded to briefly describe the operation of the regulated landfill situated immediately south of the site, in the former quarry portion of the West Lake property.

Response: *a) The text has been expanded to describe the operation of the regulated landfill situated immediately south of the site, in the former quarry portion of the West Lake property. See the text for further details.*

Comment: b) The reference to U.S. EPA in the second to last sentence on Page 2-1 is an incomplete reference and apparently not included in the references presented in Section 11. The text in this section and Section 11 must be modified accordingly.

Response: *b) The text has been revised to read "The USEPA Aerial Photographic Analysis of the West Lake Landfill Site Bridgeton, Missouri, suggests that waste disposal began as early as 1953."*

Comment: c) The text on Page 2-1 last sentence should state that landfilled material allegedly <u>included</u> municipal refuse, industrial solid and liquid wastes, and construction and demolition debris.

Response: *c) The text has been revised to read "Landfilled material allegedly consisted of municipal refuse and construction and demolition debris. Evaluations of information made by USEPA alleged that industrial solid and liquid wastes may have been disposed at the Site."*

Comment: d) The text on Page 2-3 indicates radioactive material originated from the processing of uranium at the "Mallinckrodt Nuclear Processing Plant on Destrehan Street". The designation "Mallinckrodt Nuclear Processing Plant" is not identified in St. Louis site documents, and does not seem plausible as a name that Mallinckrodt would have used since Mallinckrodt was not reportedly performing "nuclear processing" to any significant extent. The text should be modified to expand the discussion.

Response: d) *The text has been revised to read "... the processing of uranium at the Mallinckrodt Chemical Works Plant on Destrehan Street ..."*

3. <u>Section 2.2.2. Page 2-4</u>

Comment: The discussion of the Radiation Management Corporation (RMC) study must be expanded to more fully describe the activities and evaluations conducted during the investigation. Samples of water and vegetation were submitted for radioactive analysis during the investigation. In addition, gas enumeration and buildup to on-site buildings was conducted. The text must be modified as requested.

Response: *The text has been expanded to provide additional detail of the activities and evaluations conducted during the investigation. See the text for further details.*

4. <u>Section 2.3. Pages 2-4 and 2-5</u>

Comment: a) The last paragraph on Page 2-4 lists uranium and thorium processing activities. It is not clear why the entry for (5), "conversion of UF4 to U02 or uranium oxide" is listed as a process separate from process (1) "manufacturing of uranium dioxide (U02) . . .". This apparent discrepancy must be addressed.

Response: a) *The stages of uranium and thorium processes are cited from the December 1992 Workplan for the Remedial Investigation/Feasibility Study - Environmental Impact Statement for the St. Louis Site. This reference has been noted in the text.*

Comment: b) The text in the last paragraph on Page 2-5 discusses "barium sulfate raffinate". This term is a misnomer since barium sulfate is not a raffinate.

Response: b) *The text has been revised to read "The 8,700 tons of barium sulfate disposed at the Site was among these materials."*

5. Table 2-1

Comment: a) The entry for 1962 includes industrial wastes among classes of materials disposed, even though it is stated elsewhere (Page 4-1) that only a single document suggests that industrial wastes may have been disposed in the unregulated landfill. This table also is not consistent with Section 2.2.1, Site Operation History, which states (Page 2-1) that landfilled material allegedly consisted of municipal refuse, and construction and demolition debris. Further, the first paragraph in Section 4.5 states that only municipal and demolition waste was disposed in the unregulated landfill. The text and or table should be modified accordingly. Unless it can be documented that industrial waste was not disposed at the site, the investigation must evaluate potential contamination from industrial wastes.

Response: a) The text has been revised to read "The disposal of wastes and debris began at the West Lake Property."

Comment: b) The entry for 1967 states that the Commercial Discount Corporation of Chicago foreclosed the mortgage on Continental's assets and took possession of the residues with the <u>intent</u> to reduce the moisture content of the material and to ship it to the Cotter Corporation facilities in Canon City, Colorado. Please provide the information on how the authors know the "intent" of Commercial Discount Corporation of Chicago.

Response: b) The text has been revised to read "The Commercial Discount Corporation of Chicago, Creditors to Continental Mining and Milling Company, foreclosed the mortgage on Continental's assets and took possession of the material to ship it to the Cotter Corporation facilities in Canon City, Colorado."

Comment: c) The entry for the February 3, 1992, activity should be modified to indicate the Nuclear Regulatory Commission (NRC) and U.S. Real Estate personnel participated in the site walkover/site examination.

Response: c) The text has been revised to read "... examined by representatives of Region VII USEPA, MDNR, Metcalf and Eddy (EPA contractor), Nuclear Regulatory Commission (NRC), U.S. Real Estate, and Laidlaw Waste Systems, Inc. (landfill operator)."

Comment: d) The August entry stating "U.S. EPA Region VII sent a Special Notice Letter ... formal negotiation with EPA to commence upon receipt of the letter" should be dated August 11, 1992.

Response: *d)* *The text has been revised to read "(August 11)."*

Comment: e) The following entries should be added to complete the chronology of events.

1992 (September 2) - Meeting held between U.S. EPA and members of Respondent Group.

1992 (October 15) - 60 day special notice negotiation moratorium expired.

1992 (October 15) - Respondent Group requested an extension of the special notice negotiation moratorium until November 1, 1992.

1992 (October 27) - U.S. EPA grants Respondent Group's request for extension of special notice negotiation moratorium until November 1, 1992.

1992 (October 30) - Respondent Group submits offer to perform Phase I of a phased approach RI/FS to EPA.

1992 (November 6) - U.S. EPA informs Respondent Group that its October 30 , 1992, offer is not considered a "good faith offer" in accordance with the August 11, 1992 special notice letters.

1992 (November 10) - U.S. EPA, Cotter, Laidlaw, and Rock Road met.

1992 (November 16) - U.S. EPA and Respondent Group agree to conclude RI/FS negotiation by December 16, 1992.

Response: *e)* *The December 1, 1992, December 1992, and March 3, 1993, entries has been deleted.*

Comment: f) The entry for 1993 (March 3) should state the AOC/SOW was executed by U.S. EPA Director, Waste Management Division initiating the RI/FS process.

Response: f) This entry has been deleted as stated above.

6. Section 3.1, Page 3-1

Comment: The second and third paragraphs state that the area lies within two physiographic provinces - the Dissected Till Plains and the Ozark Plateau. The Dissected Till Plains is actually a physiographic subprovince of the Central Lowland Province. (Stohr, C.J., G. St. Ivany and J.H. Williams. 1981. Geologic Aspects of Hazardous-Waste Isolation in Missouri. Missouri Department of Natural Resources, Division of Geology and Land Survey. Engineering Geology Report No. 6, 55pp.).

Response: The text has been revised to read "... lie within the Dissected Till Plains of the Central Lowland physiographic province. The remainder of the area is part of the Salem Plateau of the Ozark Plateau physiographic province. (Miller, et al., 1974.)

7. Figures 3-1 and 3-2

Comment: a) Figures 3-1 and 3-2 are illegible. The figures should be enlarged and presented as attached plates. Figure 3-1 must be modified to illustrate the surface water body situated immediately north of Area 2. The figure should be modified to illustrate the approximate boundary of the regulated landfill, particularly in the vicinity of Area 1. In addition, this figure, or an alternate appropriate figure, must delineate the approximate extent of bedrock quarry activities. This information is very important in regard to proper scoping of the groundwater characterization. The GB-1 through GB-6 series borings should be described in the text.

Response: a) Figures 3-1 and 3-2 have been enlarged to 11" X 17" size for better legibility. Figure 3-1 will be modified to illustrate the surface water body situated immediately north of Area 2. The GB series of borings have been omitted from all figures.

Comment: b) The source of data used to prepare Figure 3-2 should be identified on the figure. As indicated in the text, surface topography in the vicinity of Area 2 has been modified during the past few years by the disposal of additional fill debris. It is not clear whether the surface topography presented on this figure is based on current topographic mapping. The figure should be modified as requested.

Response: *b) Reference has been given regarding the source of information and with regard to recent modifications which may not be reflected.*

8. Section 3.2.2.1, Page 3-6

Comment: The text in the last sentence on Page 3-6 indicates that the bedrock and alluvial aquifers are not utilized for a significant portion of the water supply for the St. Louis area. The populations served by the Mississippi River valley alluvial aquifer and regional bedrock aquifers must be identified.

Response: *The text has been revised to read "The bedrock and alluvial aquifers account for 1 and 2 percent of the total pumpage, respectively. (Miller, et al., 1974) These aquifers are not utilized for the St. Louis metropolitan area water supply. Only private water wells drain from the alluvial and bedrock aquifers (see Section 3.4 for further details)."*

9. Section 3.2.2.2. Page 3-7

Comment: This section fails to discuss surface water in the immediate vicinity of the site. The hydraulic relationship between surface water adjacent to Area 2 and groundwater must be evaluated. In addition, potential surface water contamination must be addressed during this RI/FS. Based on information presented in previous hydrogeologic investigations conducted at the site, it is apparent that this surface water is hydraulically connected to groundwater beneath the site. This surface water may be impacted by surface water runoff from the site, groundwater discharge and leachate throughflow. This section must be expanded accordingly.

Response: *This comment is not in the appropriate section for the site hydrology. This comment is addressed in Section 3.3.2. A staff gage will be placed in appropriate surface water bodies and monitored.*

10. Section 3.3.1.1 Page 3-7

Comment: The term "soils" appears to be used inappropriately to describe unconsolidated sediments. The description of soils and unconsolidated sediments should be described separately.

The second sentence, second paragraph states "These logs, complied from ..." and should be changed to "These logs, compiled from ...".

Response: *The text has been revised to differentiate between soils and unconsolidated sediments. See the text for further details.*

The text has been revised to read "These logs, compiled from ...."

11. Figure 3-4

Comment: The figure indicates that the alluvial profile consists of silts, sands and gravels. As indicated in the boring logs presented in this figure and logs of other borings as presented in previous investigations, the alluvial section is dominated by sands and gravels, especially at the northern portion of the site. The figure should be modified accordingly.

Response: *No change to the figure is necessary. The borings were based on geologic logs provided in pre-existing reports and transposed from the original data. Every effort was made to retain the terminology used on the original logs.*

12. Figure 3-5

Comment: a) The screen depths for wells D-92, I-72 and I-73 should be identified. The figure should be modified accordingly.

Response: *a) The screen depth for well D-92 has been identified (bottom 20 feet). Wells I-72 and I-73 have no data pertaining to the screen depths. The boring logs do not denote where the screen was set or if screen was set. The figure has been modified accordingly.*

Comment: b) The significance of the bedding altitude (dip of the unit) of the silty clay must be described in the text. Figures 3-4, 3-5, 3-6 and 3-7 indicate that the silty clay unit dips in several directions across the site. It appears that the hydraulic characteristics, thickness, lateral extent and bedding altitude of the silty clay unit are important characteristics that need to be fully addressed. These data needs must be considered when scoping the investigation of groundwater flow in perched settings, leachate migration in the vadose zone and potential migration pathways to groundwater. The text in the appropriate section should describe how the location, lateral continuity, and hydraulic characteristics of the silty clay unit will be investigated. In addition, the appropriate section must describe how leachate and possibly perched groundwater above the silty clay unit will be investigated.

Response: *b)* *The connection between material types on the logs have been eliminated from Figures 3-4, 3-5, 3-6, and 3-7. The lateral extent of the clay layer will be determined during the Remedial Investigation.*

13. <u>Figure 3-6</u>

Comment: a) The silty clay unit in the vadose zone does not extend above the former ground surface (native soil surface below refuse) and, therefore, should not extend up into the fill debris toward well D-94. The figure should be modified accordingly. It is not clear why the relatively thin silty clay unit is shown underlying a majority of Area 2 when perimeter borings D-93 and D-94 did not encounter this silty clay unit. It appears the extent of this potential clay lense has been over estimated. The lateral continuity of this unit must be investigated.

Response: *a)* *The connection between material types on the logs have been eliminated from Figure 3-6, as stated above.*

Comment: b) The base of the silty clay unit is referred to as an "aquitard base". The hydraulic characteristics of the silty clay unit have not been defined. Gradients across and within the unit have not been investigated. In addition, the lateral extent of this unit has not been fully determined. Therefore, it appears premature to consider this unit an aquitard. The figure should be modified accordingly.

Response: *b)* *The term aquitard base has been eliminated from Figure 3-6.*

14. <u>Section 3.3.1.1, Page 3-13</u>

Comment: a) The text in the third sentence on Page 3-13 indicates that the upper ten feet of the soil profile consists of organic silts and clay. This generalization is not supported by the boring logs presented in previous investigations and this workplan. The unconsolidated section at boring/well locations D-83, D-93, D-94 and D-85 indicate that sand is found beneath the fill material and is the upper native deposit. The text must describe the apparent discrepancy between unconsolidated stratigraphy beneath the site and stratigraphy immediately surrounding the site. Site boring logs indicate a silty clay to clayey silt unit in the vadose zone, however, logs from the site perimeter borings fail to recognize the silty clay unit.

Response: *a)* *The sentence indicating the upper 10 feet of the soil profile consists of organic silts and clay has been removed.*

Comment: b) The last sentence in the first paragraph on Page 3-13 indicates that flow through the soil is controlled by the relative permeability of localized areas of more permeable (coarse) and less permeable (fine) materials. The generalization that flow is controlled by permeability is an oversimplification. Permeability is an important factor in affecting flow, however, many other variables contribute to controlling flow conditions. The text should be modified accordingly. In addition, the text must be modified to reference the source of information presented in this section.

Response: *b)* *The sentence indicating that flow through the soil is controlled by the relative permeability of localized areas of more permeable (coarse) and less permeable (fine) materials has been removed.*

15. <u>Figure 3-8</u>

Comment: The figure infers that the alluvium fills the void between bedrock and ground surface, however, there is no representation of the debris/fill deposits. The refuse profile should be illustrated on this diagram.

Response: *Figure 3-8 has been removed from this document.*

16. Section 3.3.2.1 Page 3-15

Comment: The text discusses "major" and "minor" aquifers. These terms must be defined. The text must identify whether the limestone aquifer is used a potable water resource in the region. The text in the third paragraph states that groundwater surface elevations at the site are influenced by the Missouri River stage. Figure 3-10 shows a relationship between Missouri River stage and groundwater elevation, however, the limited data does not indicate that groundwater and/or surface water is influenced by river stage. The previous investigations failed to adequately assess precipitation and the site water balance (specifically precipitation/recharge as related to groundwater surface fluctuations). Additional investigation will be necessary to demonstrate the relationship between precipitation, river stage and groundwater surface fluctuations. The text should be modified accordingly.

Response: *The reference to major and minor aquifer has been removed and the terms alluvial and bedrock aquifers, respectively, have been utilized. A water balance will be computed from the data collected during the investigation.*

17. Figure 3-9

Comment: The figure inaccurately represents the bedrock erosion surface in the immediate vicinity of Area 1. A review of aerial photographs indicate that bedrock was exposed at the near surface at the northeast edge of the former quarry at approximately 440 feet. The top of the bedrock erosion surface in the vicinity of the location of the intersection of the 410-foot contour and the current landfill area (former quarry) appears to be approximately 445 feet based on aerial photograph review. Aerial photographs show bedrock exposed near ground surface immediately south of Area 1 in the former quarry (closed portion of the regulated landfill). The edge of the alluvial valley is probably closer to the "Buried Valley Bedrock Wall" as shown on Figure 1-2 in the Hydrogeologic Investigation, West Lake Landfill, October 1986. The edge of the valley wall is important because of developed vertical gradients and potential recharge to the lower portion of alluvial aquifer and bedrock and the potential for the development of shallow groundwater divides caused by bedrock groundwater extraction (dewatering) in the active landfill.

Response: *We have limited the extent of extrapolation of the data from known data points and have redrawn the contours of the figure.*

18. Table 3-2

Comment: The entries for "completion date" for wells 1206, HL-3 and HL1 are incorrect. The table should be reviewed for incorrect and inconsistent entries and modified accordingly. The acronyms used for the "Consultant" should be defined on the table.

Response: *No data is available to clarify the completion date for wells 1206, HL-3, and HL-1. A more appropriate designation, "ukn" - unknown, was used for these instances. The text was revised to define the acronyms used for "Consultants".*

19. Section 3.3.2.1. Page 3-30

Comment: The first sentence on Page 3-30 indicates that groundwater flow direction is northwest, however, Figure 3-11 indicates that groundwater flow across a majority of the site, including Area 2 is toward the northeast. The text and figure must be modified to be consistent. A review of the data presented in previous investigations indicate seasonal fluctuations in groundwater flow direction. These fluctuations will need to be more fully evaluated during the RI/FS.

Response: *The text has been expanded to explain the methods used in preparing Figure 3-11. As discussed in the August 19, 1993, meeting, the methods were appropriate for use in this figure.*

20. Figure 3-11

Comment: Based on the groundwater surface elevations presented in previous investigations, there is a range in the magnitude of potential vertical gradients within the alluvial aquifer. It appears moderately strong vertical gradients exist at the south end of the site, in the vicinity of the bedrock valley wall, and subtle gradients exist at the north end of the site. The magnitude of these vertical gradients change seasonally, though have not been fully characterized. In addition, seasonal recharge and flow condition variations exist in the alluvial aquifer but have not been fully characterized. Therefore, it appears inappropriate to combine water levels obtained from shallow and intermediate wells to construct a piezometric surface map. Secondly, the groundwater contours presented on this map are essentially meaningless because the map is based on average water elevations. As previously stated, seasonal variations in vertical gradients and flow direction exist at the site. Piezometric surface maps should be prepared for the shallow, intermediate and deep portions of the alluvial aquifer for specific monitoring events.

Response: *See response to comment number 19. The direction of groundwater migration will be evaluated as part of this investigation.*

21. Figure 3-12

Comment: It is understood that a strong boundary condition exists between the alluvial aquifer and bedrock aquifer, however, the figure fails to infer a bedrock piezometric surface. The figure should be modified accordingly.

Response: *Figure 3-12 has been removed from the document. The direction of groundwater migration will be evaluated as part if this investigation.*

22. Table 3-3

Comment: As indicated in the comment above regarding Figure 3-11, averaged groundwater data at this site is not very helpful in characterizing site conditions. Therefore, Table 3-3 should be modified to present the depth to water for specific monitoring events.

Response: *This data is provided as historical information only and therefore is appropriate. As stated above, groundwater migration pathways will be evaluated as part of this investigation.*

23. Section 3.3.2.2, Pages 3-30 and 3-35

Comment: The text describes the old channel of Creve Coeur Creek but fails to discuss the location of the old channel in relationship to the site. It is not clear from the discussion of site drainage on Page 3-35 whether the former channel borders the eastern edge of the site. The text should be expanded/clarified appropriately.

Response: *The text has been changed to further clarify that the old channel of Creve Coeur Creek is located south of the West Lake Property. See the text for further details.*

24. Section 3.4. Page 3-35

Comment: a) The text in the second paragraph indicates that four private water supply wells are downgradient of the site; however, the text briefly describes only two of these wells. The text should be expanded to describe all of the water supply wells. In addition, the text must describe the type of well surveys previously conducted and the type(s) of activities needed to conduct a current well survey and to determine whether private wells are relevant to the site. The text must be expanded to more fully describe wells in the vicinity of the site including current use-status.

Response: a) The reference for the four private water supply well downgradient of the site could not be located and has been removed from the text. The information that is referred to has been referenced appropriately. It is not anticipated that further such well surveys will be necessary.

Comment: b) The source of information used to determine that "26 private water supply wells have been identified in a 3-mile radius of the site" must be identified in the text.

Response: b) The text has been revised to include the reference of the November 19, 1989, Foth & VanDyke memorandum.

25. Section 3.5. Page 3-36

Comment: a) It is not clear where drainage ditches along the eastern side of the site discharge. If the former channel bounds the northeastern side of the site, it is not clear how it was determined that the channel is usually dry. The discussion of the regulated landfill should be expanded to describe current groundwater dewatering activities including groundwater extraction rates and extraction well locations and groundwater discharge locations.

Response: a) The discussion of the surface water body on the northern side of Area 2 is discussed elsewhere in the responses and the operation of the current regulated landfill is referenced above.

Comment: b) The text in the last paragraph indicates that the waste material was deposited on native ground surface which is likely a silty clay. As indicated previously, the boring logs presented in previous investigations and Figures 3-4 through 3-7 in this document indicate that the silty clay is not laterally continuous and is not consistently at the former ground surface (former surface sediment type). The text should be modified accordingly.

Response: *b) The text has been revised to omit the reference to the silty clay.*

26. Section 3.6. Page 3-37

Comment: There is no discussion of the aquatic ecosystem in the surface water that bounds the northern end of Area 2. The text in this section must be expanded to discuss surface water in the vicinity of the site specifically adjacent to the northern boundary of Area 2.

Response: *The text currently includes discussion of the aquatic ecosystem in the surface water on and in the vicinity of the site. Further evaluation of the aquatic ecosystem will be made following this investigation.*

27. Section 3.6, Page 3-38

Comment: The third paragraph states that the only reptiles observed were the water snake and the garter snake. Missouri has at least 7 species of water snakes and 4 species of garter snakes. Which of these species is reported to have been observed? During the site visit on May 11, 1993, Missouri Department of Health (MDOH) personnel observed the Western Fox snake (Elaphe vulpina vulpina) on site in Area 1. This snake is state-listed as endangered.

Response: *Additional details have been added to more fully described the ecology of the site. We referred to other reports on local/regional ecology. See the text for further details.*

28. Section 3.8 Page 3-39

Comment: It is not clear why this section fails to describe the evaluation of contamination in site vegetation conducted by RMC. The text should be expanded accordingly.

Response: *The text has been expanded to include discussion of the evaluation of contamination in the site vegetation conducted by RMC. See the text for further details.*

29. <u>3.8.1.2. Pages 3-41 through 3-43</u>

Comment: a) The text at the bottom of Page 3-41 and continuing on the top of Page 3-42 states the "predominant radionuclides identified by the soil analyses were Ra-226 and U-238." Dames & Moore did indeed make this statement in its Phase III Radiological Assessment of the property northwest of the landfill, adjacent to Area 2. However, the statement was grossly in error, because thorium-230 levels were many times higher than either Ra-226 or U-238 in the reported data. The referenced Dames & Moore report did not give any basis for the statement. The clearly erroneous statement that Ra-226 and U-238 were "predominant" should not be repeated in this document. The text should be modified accordingly.

Response: a) The text has been modified to delete the reference to the "predominant" radionuclides.

Comment: b) The acronyms "IG" (intrinsic germanium) and "MCA" (multichannel analyzer) identified in the first paragraph on Page 343 should be defined in the text.

Response: b) These terms have been defined. See the text for further details.

Comment: c) The text in the second paragraph on Page 3-43 is misleading. The statement "Three-dimensional cross sections of subsurface were taken . . ." is misleading. The possible meaning of "three-dimensional cross sections" is unclear, but it is clear that the cross-sections in question are conceptually two-dimensional. The text should be modified accordingly.

Response: c) The term "Three-dimensional" has been deleted.

30. <u>Figures 3-15 and 3-16</u>

Comment: The cross sections in Figure 3-15 and Figure 3-16 are based on auger hole gamma readings that led to the conclusion that Ra-226 was present in excess of 5 or 15 picoCuries per gram (pCi/g). Two types of error potential were inherent in the methodology:

(1) Because thorium decays to radium, the same clean-up criteria are used in most guidelines for Th-230 as for Ra-226. Wherever the Th-230 levels (not detectable by gamma measurement) have been determined at this site, their level is found to be much higher than the level of Ra-226. Accordingly, the vertical and areal extent of contamination based on Th-230 being above guidelines must be considered larger than the extent of contamination based on Ra-226 being above the same guideline.

(2) The Ra-226 levels were reported by RMC to be based not on actual Ra-226 measurements in the borehole, but on the gamma radiations from its progeny bismuth-214. However, because the decay path is through gaseous radon-222, which is free to diffuse through the soil, the bismuth--214 may not represent the radium-226 level at a particular location. A particular radium-226 atom will decay to radon-222, which may diffuse out into the atmosphere during its lifetime of days, before it then decays to a particulate material that can be presumed to stay in place. Therefore, the bismuth-214 detected at a borehole location may be the progeny of radium-226 located elsewhere, and the bismuth-214 from the radium-226 at a specific borehole location may in fact be atmospheric contamination or soil contamination at a different location. This source of error would appear to be different, and likely more important, in a gassing landfill as compared to another type of borehole location. The text must be revised to identify shortcomings in previous investigations and discuss the potential impact on scoping of the RI/FS.

Response: *The text has been modified to qualify the source of the information and that the inference should be considered general. See the text for further details.*

31. Section 3.8.2.2, Page 3-49

Comment: a) The discussion of radiological contamination identified during the Dames & Moore Phase II investigation is misleading for several reasons. The text fails to describe the location of the wells installed by Dames & Moore in relationship to the site. A majority of these wells are located cross-gradient and upgradient of the site. The text in the second paragraph states "The gross alpha values reported for these unfiltered samples are also of secondary importance since the sum of the individual radionuclide concentrations do not verify the gross alpha values." It may well be that these gross alpha values are in error. However, there is no requirement that individual radionuclide concentrations should add up to the same total as the gross alpha measurement, unless every possible alpha emitter has been measured. The text should be revised accordingly.

Response: *a)* *The text has been qualified to indicate that the conclusions are those of Dames & Moore and their validity is not well established.*

Comment: b) The discussion of the Dames & Moore Phase III investigation is also misleading for several reasons. The Phase III report contains inconsistencies in the reporting of groundwater quality. Two types of results for uranium-238 are presented in the groundwater analysis results shown in Table B2. Under the heading of ISOURANIUM, anomalous results range from ND to 3.3+/-0.8 picoCuries per liter (pCi/L). Under the heading of GAMMA SCAN, uranium-238 levels include ND and a range from 510 to 1300 pCi/g. Individual sample sheets indicate a high limit of detection for those samples reported ND, and confirm that the units are pCi/g. This is an extreme inconsistency and the uranium-238 levels reported under GAMMA SCAN, if true, are indicative of groundwater contamination. The GAMMA SCAN results also show elevated levels of potassium-40 that appear to be significant. These results are also similar to results reported for the West Lake Landfill groundwater. The water sample data sheets for GAMMA SCAN show the following results and (very high) limits of detection: (All values are pci/g.)

SAMPLE	U-238	K-40	U-238 LOD[1]	K-40 LOD
F001	ND	740	650	-
F002	1300	2000	-	-
F003	610	1000	-	-
F004	ND	730	730	-
F005	510	ND	-	280
F006	ND	820	830	-
F007	650	ND	-	340
F008	690	ND	-	300
F009	640	1100	-	-
F010	ND	800	660	-
F011	ND	4500	1100	-
F012	670	1100	-	-

Notes: 1. LOD - Limits of Detection

Dames & Moore does not discuss this inconsistency between U-238 results from two different analysis methods applied to the same groundwater samples and, in fact, does not discuss groundwater results at all in the text of the Phase III Radiological Assessment. A single paragraph in the Executive Summary states that the analytical results " . . . confirm that no migration of radioactive material into the shallow groundwater has occurred under the Ford property." It goes on to state flatly that the analysis indicated no evidence of elevated U-238, then recommends an annual analysis program that omits the "gamma scan" analysis.

The text must describe the technical shortcomings of the Phase II and Phase III investigation reports and identify data gaps in the investigation of radiological contamination northwest of Area 2.

Response: *b)* *The table has been modified to reflect the correct units of pCi/L. The data will also be qualified as described above regarding the conclusions of Dames & Moore.*

32. Section 4.1 Page 4-1

Comment: a) The conceptual model suffers from oversimplification of the process and the waste that was trucked to West Lake Landfill. Saint Louis Site documents have related that the 39,000 tons of soil were reported to have been scraped from the surface of the Latty Avenue property. Even after removal of this soil, subsequent surveys of the Latty Avenue property found substantial surface contamination there, much of which was scraped up to form the original nucleus of the main engineered storage pile that is present there now. Accordingly, this soil, scraped from the surface at the time of the disposal in West Lake landfill, can be assumed to have been highly contaminated with the various raffinate residues that were handled, stored, and dried at the Latty Avenue property -- in addition to being contaminated by the leached barium sulfate cake. Further, because of the great bulk of the 39,000 tons of soil scraped from the surface, there is a great deal of uncertainty in how well the soil and the barium sulfate were mixed together. The homogeneity or heterogeneity of the resulting waste has not been adequately characterized. The conceptual model should be revised to more comprehensively and accurately encompass likely site conditions and contaminants.

Response: *a)* *The text has been modified to qualify the conclusions of previous reports. It has been stated that the information collected during the investigation will be used to determine conditions at the site, including vertical and horizontal extent and the distribution of radiological contamination.*

Comment: b) In addition, it should be noted barium sulfate is not raffinate. The text should be modified accordingly.

Response: *b)* *The term "raffinate" has been deleted.*

Comment: c) The statement "The approximate extent of this material is illustrated in Figures 3-14, 3-15, and 3-16." is misleading. This statement, even though qualified with the word "approximate," is somewhat misleading. The cross sections (two for Area 1, three for Area 2) are not sufficient to permit a three-dimensional picture of the extent of contamination in either area. Also, as commented above, these representations are based on radium-226 concentrations that are said to be derived from bismuth-214 gamma radiations that do not appear capable of representing radium-226 accurately. The text and/or figures must be modified to accurately describe site contamination.

Response: *c)* *The qualification of these figures are described above.*

Comment: d) The statement "Although one document exists in MDNR's files which suggests that industrial waste may have been disposed at the Site, this statement has not been substantiated and no documentation of such activity has been found. " is misleading. Other documentation is available within the U.S. EPA files which documents that industrial wastes have been disposed of at West Lake Landfill through 103(c) notifications. Review of aerial photographs suggest several areas at the site were used for liquid waste disposal. These liquid wastes are presumably not municipal wastes and should be identified as applicable.

Response: *d)* *The text has been modified consistent with earlier comments regarding the alleged disposal of industrial waste. See the text for further details.*

33. Section 4.2. Page 4-2

Comment: a) The text in the first paragraph states "Further examination of the available data indicate that earlier assessments of the Site may have overestimated the average concentrations of Ra and Th by as much as 10 to 50 times. Upon examination of available data, more precise assumptions than those previously applied have been identified which significantly affect the estimation of the radionuclide concentrations at the Site." Precision does not appear to be a characteristic of an assumption, but in any case it will be necessary to document and defend these conclusions that radioactive contamination at the site has been overestimated.

Response: *a)* *The text has been modified to discuss the sources of the conclusions presented. The text also reiterates that the results of this investigation will provide data for the necessary determinations.*

Comment: b) The second paragraph indicates that sampling data collected to date have not indicated significant priority pollutant contamination in groundwater. It is not clear why the previous investigation reports were not evaluated and assessed to determine technical errors, shortcomings and data gaps. It is understood that Section 8.0 states "it is assumed that the data previously collected at and around the site is of sufficient quality to support the evaluation and designs presented in this workplan." However, this approach is inconsistent with EPA Guidance and the AOC/SOW. Evaluation and assessment of existing data is part of the scoping phase of the RI/FS and must be completed prior to RI/FS workplan preparation. It would seem impossible to adequately scope an investigation without properly identifying the data gaps. Several inconsistencies and technical shortcomings have been identified in the Radiological Survey of the West Lake Landfill St. County Missouri prepared by RMC, Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill, St. Louis County, Missouri, prepared by University of Missouri-Columbia, and the Hydrogeologic Investigation Reports West Lake Landfill prepared by Burns & McDonnell. These shortcomings and data gaps must be addressed during the RI/FS.

Response: *b)* *Previous comments have addressed the qualifications of data to indicate the sources and possibility of short-comings in the conclusions of previous investigations. Discussion has also been presented to indicate the goals of this investigation. See the text for further details.*

Comment: c) It is premature to state that priority pollutant organic and inorganic chemicals do not appear to be a concern at the site. It has not been definitely established that industrial waste was not co-disposed with municipal waste. Aerial photographs suggest liquid waste disposal. As indicated in Section 3.8.1, Page 3-39, very few soil and sediment samples have been analyzed for organic and inorganic chemical constituents. In addition, there has been no analysis of leachate seeps and source refuse. Priority pollutant analysis must be conducted on soils and leachate.

Response: *c)* *Similar responses regarding the alleged presence of industrial wastes have indicated the type of qualifications that have been incorporated. See the text for further details.*

34. Section 4.3 Page 4-3

Comment: Mass wasting (sliding and slumping) and leachate throughflow should be added to the list of potential migration pathways. Based on site visits, review of aerial photographs and previous investigation reports (specifically the Dames & Moore reports), it appears that mass wasting is an important contaminant migration process and pathway. Based on previous investigation results and Figures 3-4 through 4-7 in this document, leachate throughflow above the "silty clay" unit appears to be an important potential pathway. In addition, leachate seeps were identified near the toe of the berm during the February 3, 1992, site visit conducted by EPA, MDNR and NRC.

Response: *The text has been expanded to include Mass Wasting (sliding and slumping) and leachate throughflow of the berm as potential migration pathways. See the text for further details.*

35. <u>Section 4.3.3, Page 4-4</u>

Comment: a) The text indicates that there is no evidence that seeps exist. The text should be modified to indicate that seeps along the north berm do occur and have been observed during site walkovers (see Comment on Section 4.3). The text must be rewritten to indicate that leachate throughflow is a complete pathway of concern. Surface water is situated immediately north of the berm that surrounds Area 2 and potentially may be impacted by leachate seeps.

Response: a) The text has been revised to indicate the potential that seeps exist along the north berm. As indicated previously, the surface water body will be sampled to determine potential migrations.

Comment b) Based on site stratigraphy, it appears imperative that leachate sampling occur. It is apparent that low permeability silty clay strata exists in the vadose zone between the waste mass and groundwater. The last sentence indicates that no leachate samples can be collected. There are several well established methods for the collection of leachate from the vadose zone. Leachate wells (lysimeters) must be installed to characterize leachate composition. It may be necessary to collect several samples to obtain sufficient volume to analyze for the parameters identified below. The installation of leachate wells will provide invaluable information regarding the depth, thickness and types of wastes, moisture content, degree of decomposition and leachate heads. Leachate samples must be analyzed for selected radionuclides, priority pollutant organics and metals and cyanide. In addition, the following analyses should be performed: biological oxygen demand (BOD), chemical oxygen demand (COD), pH, total dissolved solids (TDS), total organic carbon (TOC), chlorides, nitrite, nitrate, ammonia, total phosphorous and sulfides. These additional parameters are standard leachate indicator parameters and will help characterize the leachate and refuse.

Response: b) The text has been revised to propose sampling leachate throughflow of the berm if the volume is sufficient. See the text for further details.

36. <u>Section 4.3.4 Page 4-4</u>

Comment: The text indicates that groundwater flow tends to be to the northwest. This flow direction contradicts the flow direction illustrated on Figure 3-11. The text and/or figure must be modified to be consistent (See comment on Figure 3-11).

Response: *The text has been expanded to explain methods used in preparing Figure 3-11. As discussed in the August 19, 1993, meeting, the methods were appropriate for use in this figure. See Section 3.3.2.1 for further details.*

37. Section 4.5 Pages 4-6 and 4-7

Comment a) The conceptual site model is based on existing data evaluation and is developed before any field activities. Quantitative data should be incorporated wherever possible. The purpose of the conceptual site model is to describe the site and its environs and to present hypotheses regarding the suspected sources and types of contaminants present, contaminant release and transport mechanisms, rate of contaminant release and transport (where possible), affected media, known and potential routes of migration, and known and potential human and environmental receptors. The text needs to be expanded to include the information from previous investigations and aerial photos and to incorporate the potential of additional contaminants (i.e., hazardous substances from industrial wastes), contaminant release and transport mechanisms, rate of contaminant release ... and known and potential human and environmental receptors.

Response: a) The text has been modified to include the discussion of issues presented above, including alleged industrial wastes and qualifications of previously collected data. See the text for further details.

Comment: b) The text in the last paragraph on Page 4-6 should be revised. As indicated previously, the "soils" (unconsolidated sediments) beneath the site are not "largely silty clays and clayey silts." It appears based on boring logs of site sediments that approximately 95 percent of the unconsolidated profile is composed of sand. The text must be modified accordingly.

Response: b) The text in the last paragraph on page 4-6, referring to the "soils" beneath the site being "largely silty clays and clayey silts", has been omitted.

Comment: c) The second paragraph on Page 4-7 states "These measurements will allow reliable estimates for future direct radiation levels that will result from the ingrowth of radioactive daughter products". Estimates for future direct radiation levels, and radon emission levels as well, will be limited primarily by uncertainty in the ratio of thorium-230 to radium-226. The text must be expanded accordingly.

Response: c) *The text in the second paragraph on page 4-7, stating "These measurements will allow reliable estimates for future direct radiation levels that will result from the ingrowth of radioactive daughter products.", has been omitted.*

Comment: d) The text in the third paragraph on Page 4-7 states "The soil cover placed over the Site will limit the degree that sediments containing contaminants of concern may migrate from the Site." The migration from the site that has been "documented" is in major part migration of material directly from the berm on the north of Area 2. This does not appear to be affected by any additional soil cover that has been applied. Exposed contaminated soil in the berm north of Area 2 is being incised by surface runoff. The text must be modified accordingly. Section 5.0 must be expanded to describe how the magnitude and extent of contamination in the berms will be evaluated.

Response: d) *The investigation procedures described in this Work Plan will encompass the berm, including certain biased soil borings and the investigation grid.*

38. Section 5.1. Page 5-1

Comment: It is not clear why radiological contamination in municipal refuse materials beneath the identified radiological waste deposits are not identified in this section. A major shortcoming in previous investigations has been the failure to determine the vertical extent of radiological contamination.

The AOC/SOW identifies the need to characterize radiological contamination in refuse materials. The text must be modified accordingly.

Response: *Soil borings will determine the vertical extent of radiological contamination in the radiological and refuse materials. This will be accomplished by performing a down-hole gamma survey in all of the deep soil borings .*

39. Section 5.2 Page 5-2

Comment: The subsections in this section should be modified to more clearly identify which activities will be conducted during the Interim Measures (IM) and which activities will be conducted during the remedial investigation. Though not clearly stated, it is assumed the tasks presented in this workplan are Phase I tasks. Potential Phase II tasks have not been outlined. More important is the lack of identified action levels/contaminant thresholds and/or site risks that will trigger additional investigations. The text must be modified to identify action levels/contaminant thresholds, and/or site risks that will trigger additional site investigations. In addition, in the subsections of Section 5.0 there is no discussion of contaminant concentrations or "action levels" that will trigger additional investigation and contingency investigations have not been identified. The text must be expanded. Potential contingent investigations must be identified.

Response: *The subsections have been modified to clearly identify Phase I tasks. Potential contingent investigations (Phase II investigations) have also be identified. The term "Interim Investigation" has not been used in the revised Work Plan. Determination of the extent of radiological contamination will be based upon background levels determined by these investigation activities. See the text for further details.*

40. Section 5.2.1. Page 5-2

Comment: a) It is not clear why the text does not propose surface water sampling and leachate sampling. Surface water and leachate sampling must be proposed.

Response: *a) The text has been revised to include surface water sampling. Leachate sampling will be conducted from seeps on the north side of the berm if sufficient quantities of water are produced from each seep to allow collection of the required sample volume for radiological analysis. Staff gages will be placed in surface water bodies. These gages will be checked monthly in conjunction with groundwater elevation readings.*

Comment: b) The text fails to indicate that evaluation of data obtained during the interim measures will be used to determine the need for restriction of access to land adjacent to Area 2.

Response: *b) The text has been revised to include data evaluation of the investigation activities to determine appropriate access restrictions to land adjacent to Area 2. See the text for further details.*

Comment: c) The visual inspection of the berm should include an evaluation of differential settlement and ponding caused by subsidence. The text must be modified accordingly.

Response: *c) The text has been revised to include a visual inspection of the berm to evaluate differential settlement and ponding caused by subsidence.*

41. Section 5.2.2. Page 5-3

Comment: The text in the second paragraph indicates that structural characteristics of the berm will also be examined. (See comments on SAP, Section 6.9).

Response: This comment has been responded to in the SAP (see comment number 54).

42. Section 5.2.3. Pages 5-3 and 5-4

Comment: a) The text describes the types of site investigations in very general terms. The text indicates that the characteristics of soil and groundwater beneath the site will be determined. However, the text fails to discuss whether local or site-specific geology and site hydraulics will be characterized. Based on review of the Hydrogeologic Investigation West Lake Landfill, St. Louis County, Missouri, it appears that site stratigraphy (specifically the lateral continuity of low permeability horizons in the vadose zone ["silty clay unit"] and saturated zone) and site hydrogeology (specifically variations in flow directions and gradients and the hydraulic relationship of perched groundwater and the alluvial aquifer) have not been adequately characterized. The text must be revised to identify investigative data gaps and propose how these data gaps will be resolved.

Response: a) The text has been revised to include details of procedures to characterize site-specific geology and hydraulics. Site-specific geologic characteristics will be determined during soil boring drilling. Soil cores and/or cuttings will be classified according to the United Soil Classification system (USCS). Soil cores and/or cuttings will also be characterized as to color (utilizing Munsell soil color charts) moisture content, odor, and other distinguishing features. Site-specific hydraulic characteristics will be determined by performing slug tests as described in the text. Flow direction and gradient will be determined by measuring water levels within monitoring wells at the site.

Comment: b) The second sentence in the first paragraph should be modified to indicate that groundwater beneath the site and in the immediate vicinity of the site will be evaluated.

Response: b) The text has been revised to indicate that groundwater beneath the site and in the immediate vicinity of the site will be evaluated. See the text for further details.

Comment: c) The text in the second paragraph states "Down-hole radiation surveys will be performed in certain of these boreholes." The text fails to state the rationale for this and for choosing which boreholes will be subject to the downhole radiation surveys. The text must be modified to present the investigative rationale.

Response: *c)* *The text has been revised to present that downhole radiation surveys will provide information regarding vertical and horizontal distribution of radiological contamination. These downhole radiation surveys will be performed in each of the borings within the radiological area.*

Comment: d) The activities proposed are incomplete. Sampling of surface water, leachate and seeps must be included in the investigation of site contaminants.

Response: *d)* *The text has been revised to include surface water sampling and leachate sampling from seeps. See response to comment number 40a for details.*

Comment: e) The text indicates that the characteristics of the various fill materials will be examined. However, the workplan fails to identify investigative tasks, specifically chemical analyses to be conducted on the fill deposits. In addition, the proposed investigation will not evaluate the refuse deposits (see comment on Section 5.2.4). As indicated previously, all fill and refuse deposits must be characterized.

Response: *e)* *The physical characteristics and depth of the refuse will be described in addition to a down-hole gamma survey. Chemical analyses will be performed on samples of each of the deep borings.*

43. <u>Section 5.2.4. Page 5-4</u>

Comment: The text indicates that soil borings through the landfill material will allow examination of the occurrence of these materials. Based on the discussion of soil sampling presented in Section 6.4 and Section 3.3 in the SAP, it appears that soil sampling will be limited to the upper 20 to 30 feet below ground surface. Since the refuse profile may be more than 70 feet thick, it is apparent that the proposed characterization of the refuse profile is not possible based on the limited investigation. This section and Section 6.4 must be modified to expand the soil/refuse sampling investigation.

Response: *The text has been revised to include six deep borings in biased locations that were determined by the USEPA. These borings will be drilled to 5 feet below the refuse. The shallow borings were originally proposed to be 20 to 30 feet; however the thickness of the rad material is unknown, so it is now proposed to drill until the refuse material is encountered. See attached Table A for further clarification.*

44. Table 5-1

Comment: a) This table should be expanded to identify the contaminants of concern.

Response: *a) The table has been expanded to identify contaminants of concern. See Table 5-1 for further details.*

Comment: b) It is not clear why further control on access is not considered a preliminary remedial action. The goal of the Interim Measures, as stated in Section 5.2.1, Page 5-2, is to determine the risk of exposure at the site to radioactive emissions and to contaminant in surface soil, including erosional sediments. Soil contaminant concentrations may pose an unacceptable risk. Current control on access is not sufficient to limit access to Areas 1 and 2. During a site visit, EPA Contractor personnel observed a rabbit hunter in Area 2. In addition, currently there are no restrictions on access to the Ford Property, adjacent to Area 2. A goal of the Interim Measures should be to assess the need to control access to the Ford Property. It appears that further control on access may be a preliminary remedial action objective. The text must be modified accordingly.

Response: *b) The text has been revised to include data evaluation of the Phase I activities to determine risk of exposure to radioactive emissions, and contaminants in surface soil. Access restrictions will be determined from this evaluation. See the text for further details.*

45. Section 6.0 Page 6-1

Comment: The text states, "As discussed in the SOW, it is anticipated that the RI will be an iterative process, potentially consisting of multiple phases and that the activities described herein are only those contemplated for the first phase. Should these activities indicate the need for subsequent phases of activities, these will be determined and proposed at that time." The text should discuss what contingencies will initiate the next phase and that a workplan addendum will be necessary based on the Phase I results. As provided in our comments we believe additional work must be completed in Phase I in addition to the necessary followup during Phase II based on the Phase I results.

Response: *The text has been revised to state that the activities described herein are Phase I of the investigation. The text has been expanded to include potential contingent Phase II investigations. See the response to comment number 39 and the text for further details.*

46. Section 6.1, Page 6-1

Comment: This section or an alternate appropriate section must describe the development of Data Quality Objectives (DQOs). The text must be expanded accordingly.

Response: *The text describing the development of Data Quality Objectives has been expanded in the Sampling and Analyses Plan (SAP). See the text for further details.*

47. Section 6.2, Page 6-2

Comment: a) The text must be modified to state how the grid for the direct gamma and beta-gamma survey will be established and whether it will be surveyed and reproducible. See comments on Section 3.2 in the SAP regarding grid block size.

Response: *a) The text has been revised to describe the survey boundaries and individual grid dimensions. Individual grid dimensions will be 30 by 30 feet. Individual grid points will be surveyed by a Registered Land Surveyor so that the grid may be reproduced.*

Comment: b) The text in the second paragraph states "Open and closed window readings will be made at 1 cm with the appropriate instrument (e.g., GM or proportional counter), and the ratio of the two will be used to indicate the presence or absence of radioactive emissions." Evidently, this should say that the ratio and the difference between window-closed and window-open readings will " . . . indicate the presence of contamination on the surface vs. subsurface." The text must be modified accordingly.

b) The text has been revised to read "Open and closed window readings will be made at 1 centimeter with the appropriate instrument (e.g., GM or proportional counter.) and the ratio and the difference of the two will be used to indicate the presence of contamination on the surface versus subsurface."

47_2. Section 6.3, Page 6-2

Comment: a) The text indicates that surface water is not persistent at the site, however, as indicated previously, surface water is situated immediately north and northeast of the berm that bounds Area 2. As indicated previously, leachate seeps at the toe of the berm that bounds Area 2 have been identified. It is apparent that surface water may be impacted by leachate release and surface water runoff. Samples of surface water must be obtained as part of the investigation of potential migration pathways and potential receptors. The samples must be analyzed for the same list of parameters proposed for sediment samples.

Response: *a) The text has been revised to include collection of surface water samples. Surface water samples will be analyzed for the same analytical parameters proposed for the sediment samples. See the text for further details.*

Comment: b) The text states "At least two sediment samples will be collected in surface drainage channels to determine if radionuclides and other materials have migrated off-Site due to natural erosion processes." The contamination that can potentially be found by this task is in sediment that is downstream (in surface flow terms) from locations where contaminated soil penetrates to the surface. The report should explain how the two sampling locations will be selected to provide a realistic chance of finding such contamination, and why two samples are expected to be sufficient, and on what basis additional samples "may be collected." In addition, the text must identify "background" sampling location(s) to provide a characterization of naturally occurring contamination.

Response: *b) Sediment sample locations will be selected based upon surface flow patterns in Areas 1 and 2.*

48. Table 6-1

Comment: The "four primary nuclides" indicated are U-238, Th-230, Ra-226, and Ra-228. Radium-228, a decay product of natural thorium (Th-232) has not previously been considered a contaminant at the site. The report should explain the rationale for selection of these nuclides to be "primary".

Response: *Rationale for the primary nuclides has been provided. See the text for further details.*

49. Section 6.4, Page 6-4

Comment: a) The text indicates that certain borings may be located off the West Lake property, if such access is available. Site access must not limit the scope of the site investigation. The text should be modified to indicate that if Respondents' fail, after having exerted best efforts to gain access to property not owned or controlled by Respondents, EPA may assist Respondents in obtaining access.

Response: a) The text has been revised to state that if Respondents fail, after having exerted best efforts, to gain access to property not owned or controlled by the Respondents, EPA may assist Respondents in obtaining access.

Comment: b) The rationale for the sampling plan has not been described. The number, location and depths of the soil borings has not been described and substantiated with known site conditions. It is not clear why the data gaps of previous investigations have not been addressed in this workplan. In addition, it appears that liquid disposal areas identified on aerial photographs have not been targeted for investigation. The scope of work must be significantly expanded to investigate the vertical extent of radiological waste and potentially impacted refuse and unconsolidated sediments. In addition, data gaps and known disposal areas must be investigated.

Response: b) As discussed above, the rationale for the monitoring wells and soil borings has been expanded in the text of the workplan, including the discussion of biased samples. See attached Table A for further clarification.

Comment: c) The soil borings that are to achieve the RI/FS Data Objectives of Section 5.1 are of several types. The treatment specified for each area is similar, with a larger number of samples specified for the larger Area 2. Using Area 1 as an example, two borings located in areas showing the highest gamma radiation levels will be completed as monitoring wells. The borings will be sampled at 5-foot intervals to a depth of 25 feet. A composite sample will be obtained by taking an aliquot from each at the "point or points" in each borehole where the gamma survey indicates the highest radiation levels" and compositing into one sample that will be analyzed for the "full suite" of nuclides in Table 6-1. While it is not explained, it appears that this composite is to determine the proportions of various nuclides, including the U-235 series, for risk assessment purposes. In principal, this is a valid concept. However, because of the variability of the waste, the use of only one sample of two to four aliquots from all of Area 1 seems to offer too much error potential. Further, the selection on the basis of the highest aboveground gamma reading seems only to assure that these boreholes will be located where the contaminated soil lies closest to the surface. Looking at the cross-sections, it does not appear that the locations where contamination is close to the surface are generally good representative locations within the major portions of the waste.

Response: *c)* *Continuous soil cores will be collected when possible and will be evaluated.*

Comment: d) The largest number of borings will be located throughout Area 1, at randomly selected intersections of the grid used for gamma survey. These will be 30 feet deep and sampled at the 5-, 10-, 15-, 20-, 25-, and 30-foot locations. Similarly, four borings will be drilled around the perimeter of the area, 20 feet deep, sampled at 5-, 10-, 15-, and 20-foot locations. These samples at 5-foot intervals, from all 18 boreholes will be screened with a GM survey instrument and the two highest reading from each boring will be analyzed for the "primary" nuclides, uranium-238, thorium-230, radium-226, and radium-228. The concept of analyzing a representative number of samples and determining accurately the ratios between thorium-230 and radium-226 in particular, is appropriate. However, looking at the existing cross-section representations and data presented in previous investigations, it appears that the great majority of samples taken at five-foot intervals in boreholes located primarily at random, may not be in contaminated waste at all. Further, some of the boreholes will likely not yield any samples (from the five-foot interval locations) that are in the contaminated waste. The rationale for selecting borehole locations at random, rather than on the basis of filling in data gaps, should be justified or changed. Similarly, the collection of samples from five-foot intervals without regard to gamma readings in the borehole should be justified.

Response: *d)* *The text has been revised to present the rationale for selecting borehole selections at random. The boreholes will be randomly selected utilizing numerically designated gamma survey grid intersection points. A random number of generator will be used to specify particular grid intersections where borings will be located. See the text for further details.*

Comment: e) The proposed boring depths are insufficient. Contamination has been identified at the terminal depth of boring 22 (25 feet) as determined during the RMC study. In addition, as indicated previously, the extent of radiologically impacted soils and refuse beneath the radiological waste has not been evaluated. There is no discussion of how refuse thickness or potential contamination of soils and refuse materials beneath the radiological waste will be determined. It appears that a few continuously sampled borings are needed to fully characterize the refuse profile and unconsolidated stratigraphy and to determine the extent of radiological waste and radiological contamination.

Response: e) As describe in the response to Comment 43, new boring depths have been proposed to more fully characterize the refuse profile and unconsolidated stratigraphy.

Comment: f) It is not clear why there is no discussion of contamination in the berm adjacent to Area 2. It is not clear why no borings have been targeted for the berm areas. The text must be expanded and clarified.

Response: f) The berm is included within the gamma survey grid and it is anticipated that certain of the bias samples will be located on the berm. See the text for further details.

Comment: g) It is not clear why landfill gas sampling, in addition to the borehole monitoring activities identified in SAP during boring advancement, has not been proposed. Landfill gas sample analysis can help determine whether volatile organic compounds in landfill gas act as a source of contamination to groundwater. In addition, landfill gas analysis is needed for a complete site health and safety evaluation (specifically air toxics and explosives) and for a comprehensive human health assessment.

Response: g) The text has been revised to state that monitoring will be conducted during drilling. Monitoring parameters will include: LEL and oxygen for explosive atmospheres, volatile organic compounds (VOCs), and direct radiation measurements. All monitoring will occur at the borehole and at worker breathing zones. In addition, headspace for VOCs and radioactive monitoring will be conducted on soil cores and/or cuttings.

50. <u>Section 6.5 Page 6-6</u>

Comment: a) There is no discussion of perched groundwater above the silty clay unit. The Hydrogeologic Investigation identified perched groundwater but failed to evaluate the hydraulic relationship of the perched groundwater and alluvial groundwater. This section must be expanded to include potential perched groundwater wells and leachate wells/lysimeters.

Response: a) The text has been revised to state that, as part of logging procedures for soil borings, moisture content will be noted. This will identify any zones of saturation if present. This information will be evaluated to determine the feasibility and need for additional examination of leachate.

Comment: b) It is not clear why no nested wells have been proposed. It appears that additional information is needed to evaluate potential vertical gradients in the vicinity of Areas 1 and 2. There is more than 100 feet of alluvial sediments in the vicinity of Area 2 and groundwater data suggest that very low potential vertical gradients exist in the vicinity of Area 2. Therefore, it is not clear why no intermediate alluvial wells have been proposed in the vicinity of Area 2. Area 1 is characterized by a thinner alluvial section and moderately strong vertical gradients have been identified. Therefore, no intermediate alluvial wells appear necessary. The RI/FS Workplan must be expanded to include intermediate wells at Area 2.

Response: b) The text has been expanded to include a well cluster on the east boundary of Area 1 and an additional alluvial well to the northeast of Area 2. The well cluster will consist of a bedrock well and an alluvial well.

Comment: c) Based on unknown physical and hydraulic properties of the upper bedrock profile, it is suggested that bedrock wells be cased five feet into competent bedrock.

Response: c) The text has been revised to state that bedrock wells will be cased 5 feet into competent bedrock.

Comment: d) The text on Page 6-7 describes the locations of the monitoring wells to be installed in Area 1 and Area 2. However, it is not clear why no replacement wells for former wells I-59 and D-93 have been proposed. Analytical data indicates that groundwater collected from these wells has been impacted. In addition, these wells are, at least seasonally, downgradient of Area 2. These wells should be replaced. In addition, Figure 3-11 shows groundwater flow toward the east in the vicinity of

Area 2, however, there are no shallow alluvial monitoring wells in this vicinity. Additional shallow alluvial wells must be proposed.

Response: d) *The text will be revised to state that well D-93 will be utilized for groundwater monitoring. Well I-59 was previously abandoned and will not be restored or utilized for groundwater monitoring. As stated previously in the response to Comment 19, the text has been expanded to explain the methods used in preparing Figure 3-11. See text for further details.*

51. Section 6.6. Page 6-9

Comment: There is no discussion of how the hydraulic properties of the "silty clay" unit will be evaluated. The text must be expanded to describe the techniques to be used to evaluate this unit.

Response: *The text has been expanded to state that one sample of the "silty clay" unit from each of the deep borings, if the unit is encountered, will be submitted to a geotechnical laboratory for grain size analysis. Based upon this analysis, an estimate of the permeability of the "silty clay" unit will be made. See the text for further details.*

52. Section 6.7 Page 6-9

Comment: a) There appears to be discrepancy in site data regarding groundwater flow direction and the relationship between site groundwater flow characteristics and Missouri River stage. These discrepancies must be identified and rectified during the investigation. The surface water body situated immediately north of Area 2 must be monitored. The text must describe the surface monitoring stations (63, 64 and 67) identified in the Reitz & Jens, Inc. letter to Dr. David Bedan, Director of Waste Management Program, dated March 31, 1983. It appears that these stations, if still existing, must be monitored. The text must describe how these monitoring activities will be conducted.

Response: a) *As stated in the Work Plan, groundwater elevations will be measured on a monthly basis for a period of six months. As stated previously, staff gages will be installed in surface water bodies at the Site during Phase I activities. These gages will be monitored with the same frequency as groundwater elevations. The Missouri River stage reading will also be obtained for the period of time that water level readings are measured.*

Surface monitoring stations 63, 64, and 67 will be located during Phase I activities. If existing, these stations will be monitored concurrently with the 24 monitoring wells.

The text has been expanded to include groundwater and surface water monitoring procedures and schedules. See the text for further details.

Comment: b) The text must be expanded to indicate that, at a minimum, groundwater level measurements will be recorded monthly for at least six months.

Response: b) The text currently reads: "each well will be measured each month for a period of six months."

53. Section 6.8. Page 6-9

Comment: a) The text indicates that wells I-59 and D-92 will be sampled, however, Table 3-2 indicates that well I-59 was abandoned in October 1992 and well D-92 is missing. Alternate wells must be proposed. In addition, suggested replacement wells and additional wells identified in comments on Section 6.5 must be identified in this section. This must include, at a minimum, three leachate wells/lysimeters, replacement wells for former wells I-59 and D-93 and an additional shallow alluvial aquifer well situated east of Area 2 and an additional mid-depth alluvial aquifer monitoring well downgradient of Area 2. If newly installed wells indicate contamination, additional wells will be required.

Response: a) As stated in the response to comment 50d, well D-93 will be utilized for groundwater monitoring, but Well I-59, previously abandoned, will not. Well D-92 will be located utilizing surveyors coordinates and will be restored, if necessary. In reference to the installation of lysimeters, see response to comment 50a.

Comment: b) It appears that wells S-60, D-87 and D-94 and D-90 and S-82, if existing, should be included in those existing wells which will be sampled. Sampling of these wells have indicated groundwater contamination in the past and are well situated to assess site contamination.

Response: *b)* *The text has been revised to state that wells D-87, D-94, and S-82 will be located, restored, and included in the groundwater monitoring and sampling plan. Well D-90 is too distant from the subject area to provide useful information.*

54. Section 6.9 Page 6-10

Comment: The text should be expanded to include the tasks necessary to characterize berm soils (grain size, grain texture, soil moisture, etc.). In addition, an erosion surface evaluation and evaluation of potential slumps, slides and flows must be conducted. The text must be modified accordingly.

Response: *The text has been expanded to state that one representative sample of berm soil will be submitted to a geotechnical laboratory for grain size analysis. Based upon the results of the grain size analysis, the permeability of the berm will be estimated. The berm soil will also be described in the same manner as soil cores and cuttings from the soil borings (see response to comment number 42a). The text has been expanded to include an erosion surface evaluation and evaluation of potential slumps, slides, and flows of the berm. See the text for further details.*

55. Section 6.10 Page 6-11

Comment: As indicated in comments on Section 6.4, landfill gas must be evaluated in order to prepare a comprehensive baseline risk assessment for the site.

Response: *See response to comment 49g.*

56. Section 7.2 Page 7-2

Comment: a) The statement in the first paragraph, "Under CERCLA as amended, ..." should be changed to "Under CERCLA, ...".

Response: *a)* *This change has been made.*

Comment: b) The statement, "... other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically ..." in paragraphs 3 and 4 should be changed to "other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically ...".

Response: *b)* *This change has been made.*

57. Table 7-1

Comment: The "Comments" entries on Page 4 of 5, Table 7-1 indicate that no critical habitats exist in the affected area. The table must be expanded to provide the reference for this information.

Response: *This information has been provided. See Table 7-1 for further details.*

58. Table 7-3 Page 9 of 10

Comment: Please indicate the units for the concentration of radionuclides in air presented in this table.

Response: *The units of uCi/ml have been indicated.*

59. Section 7.4 Page 7-50

Comment: The last bullet should state "In developing appropriate remedial alternatives, the NCP contains the expectation that engineering controls, such as containment, will be used for wastes that pose a relatively low long-term threat or where treatment is impracticable." [NCP § 300.430(a)(1)(iii)(B)]

Response: *The stated change has been made.*

60. Section 7.4 Page 7-51

Comment: It is not clear why "hot spot" excavation/treatment is not included in the preliminary list of remedial alternatives. The text must be expanded accordingly.

Response: *"Hot spot" excavation/treatment has been included in the preliminary list of alternatives.*

61. <u>Section 8.0 Page 8-1</u>

Comment: The first bullet item in this section indicates that it was assumed that data previously collected at the site is of sufficient quality to support the evaluations and designs presented in this workplan. This assumption should not have been made. Data evaluation and assessment is an integral part of the scoping process. EPA has identified many technical shortcomings and data gaps in previous investigations and potential contaminant "hot spots" in aerial photographs. The respondents must evaluate all existing data to properly scope the RI/FS.

Response: *This text has been modified to indicate that the data provided by previous investigations has been evaluated based on available information. Certain qualifications of the information have been made earlier in the Work Plan. To the extent that these data have been utilized in this Work Plan, the Respondent Group and McLaren/Hart cannot evaluate the validity of these data beyond the available information and do not provide any guarantee of the validity of these data.*

62. <u>Figure 9-1</u>

Comment: The Figure or text in Section 9.0 must describe why the limited field investigation will take six months to complete. Specific field investigation tasks including surface water and groundwater monitoring events should be identified on the Gantt diagram. Deliverables should be identified on the diagram.

Response: *After the scope of investigation tasks has been completed, the schedule detail will be evaluated and an appropriate time frame will be determined.*

63. <u>Section 9.0. Page 9-4</u>

Comment: Under Task IV, the statement, "This Memorandum shall be submitted to USEPA within 45 days of concurrence that Treatability Studies are necessary." The statement should state, "This Memorandum shall be submitted to USEPA within 45 days of EPA's determination that Treatability Studies are necessary."

Response: *The text has been revised to read "This memorandum shall be submitted to USEPA within 45 days of EPA's decision that Treatability Studies are necessary."*

64. Section 9.0, Page 9-6

Comment: It is not clear why the Comparative Analysis Technical Memorandum will be submitted within 60 days of EPA approval of the RI Report. The appropriate rationale must be presented.

Response: *Given that this document is very significant in the process of determining the remedy for this site, this time frame does not appear inappropriate. This seems to be substantiated by the fact that the AOC provides a period of 45 days for preparation of a revision to this document, if required.*

65. Section 10.1, Page 10-1

Comment: The responsibilities/roles of the technical project personnel should be defined in the text.

Response: *The roles and responsibilities of key technical project personnel have been discussed in the text.*

66. Section 10.3, Page 10-3

Comment: The text should be expanded to identify where the project file will be stored and identify the length of time the file will be maintained. In addition, the text must describe how the restrictions on access to the file will be provided.

Response: *Such discussions have been provided in the text. See the text for further details.*

67. Section 10.4 Page 10-4

Comment: The text should be expanded to include the Data Quality Objectives (DQOs) requirement necessary for both risk assessment and the evaluation of remedial alternatives. The workplan should illustrate how the field investigative activities will satisfy the data needs. The data quality/quantity needs will need to be determined for each specific task for each environmental medium sampled.

Response: *The text has been expanded to provide this detail.*

68. Section 10.4.3. Pages 10-6 and 10-7

Comment: The text should be expanded to describe the evaluation of surface water data collected from the pond adjacent to the north end of Area 2.

Response: This information has been provided. See the text for further details.

APPENDIX A

Section 3.2 Table 3-1

69.
Comment: Confined spaces are shown as not present on the West Lake Landfill site. However, Table 3-1 does indicate the presence of holes/ditches. According to 29 CFR 1926.21(6)(6)(ii), open top spaces (pits, tubs, vaults, vessels, etc.) More than 4 feet in depth qualify as confined spaces.

Response: The Respondent Group is not aware of and does not anticipate that confined space entry will be encountered during the activities contemplated for this investigation. In the event that unforseen conditions will be encountered, the appropriate modification has been made to the Health and Safety Plan.

APPENDIX B

70. Section 1.0. Page 1-1

Comment: Air, surface water and leachate must be added to the list of environmental media to be evaluated. See comments on the RI/FS Workplan.

Response: These media have been added, as appropriate from the changes made to the Work Plan.

71. Section 2.0. Page 2-1

Comment: The list of analytes should be expanded to include standard leachate indicator parameters. An appropriate list of parameters has been presented in the comment on Section 4.3.3 in the RI/FS Workplan.

Response: *Samples of leachate collected at expressions from the berm will be analyzed for BOD, COD, pH, TDS, TOC, chlorides, nitrate, nitrite, ammonia, total phosphorous, and sulfide.*

72. Section 3.0. Page 3-2

Comment: The text must be modified to include sampling of surface waters adjacent to Area 2. The surface water north of Area 2 is not intermittent as suggested in the text.

Response: *As discussed previously, sampling of surface water has been discussed. See the text for further details.*

73. Section 3.2. Page 3-1

Comment: a) The text indicates that the standard grid block size to be utilized for this survey will be 75- by 75-feet. This grid size is too large to provide a reasonable expectation of detecting local features. The 10- by 10-feet grid, used by Dames and Moore in their Phase III investigation of the adjacent property, would seem appropriate.

Response: *a)* *The Respondent Group feels that a grid spacing of 10 by 10 feet is excessive in this case given the delineation of local features necessary and the total area to be covered. An alternative grid spacing of 30 by 30 feet has been proposed and accepted.*

Comment: b) The text in the second paragraph states "A gamma-sensitive survey instrument will be used . . ." Perhaps this was originally intended to say a sensitive gamma instrument. Nearly all radiation instruments can be called gamma-sensitive, but few are capable of the sensitivity to read normal gamma background accurately. A specification is needed. Also, it is not made clear, but the open- and closed-window readings at 1 centimeter, if a GM counter as suggested, will likely be a different instrument from the sensitive gamma instrument that is used to record micro-Roentgen readings. Specifications on instruments are needed.

Response: *b)* *This text has been clarified. See the text for further details.*

74. <u>Section 3.3, Page 3-2</u>

Comment: a) The description of soil borings in the second paragraph discusses "hot spots" as drilling locations, and is inconsistent with (i.e., does not set forth) the rationale given in the workplan. The text also indicates that if no distinct "hot spots" occur boring locations will be selected from random placement. The process of random selection must be presented. More importantly, previous investigations have identified potential hot spots and have not fully evaluated the nature and extent of contamination at these hot spots. In addition, aerial photographs suggest liquid disposal areas. These previously identified hot spots, data gaps in existing site characterizations and disposal areas must be targeted during boring installation. The scope of work to be performed must be significantly revised and expanded. The text in the third paragraph describing soil sampling is confusing. The text indicates that soil samples will be collected at 5-foot intervals utilizing continuous core soil samplers. Most conventional continuous core samplers are 5-foot in length. If these samplers are used to collect samples on 5-foot centers, soil will be collected continuously. The text must address this apparent discrepancy. As indicated in comments generated on the RI/FS Workplan, a few continuously sampled borings will be needed to characterize the waste deposit, refuse profile and unconsolidated section. All borings installed for well installation should be sampled continuously. In addition, at a minimum, three additional borings in Area 1 and three borings in Area 2 should be sampled continuously to the silty clay unit or water table, whichever is encountered first. These borings must be located at previously identified hot spots or at locations where liquid waste disposal may have occurred based on aerial photograph review.

Response: a) As discussed under earlier comments, more detail of the procedures to be utilized for establishment of the grid, selection of "hot spot" locations, biased locations, and random locations have been provided. The soil coring procedures have been clarified. See the text for further details.

Comment: b) It is not clear why hollow stem auger drilling is being proposed for those areas where refuse may be penetrated. The text must be expanded to describe the rationale for selecting hollow stem auger drilling.

Response: b) The text has been expanded to discuss the techniques that may be used for drilling, including hollow-stem augers, fluid rotary, and other alternatives. See the text for further details.

Comment: c) The text must be expanded to identify the minimum descriptions to be recorded in the field log book during soil description. The text should indicate that soil consistency, density, plasticity, grain size and moisture content will be characterized. For cohesive soils moisture content related to plastic limit will be described. In addition, soil staining, discoloration and changes in density must be described, if applicable.

Response: *c)* *The referenced details have been provided. See the text for further details.*

75. <u>Section 3.3.1 Page 3-3</u>

Comment: The downhole logging technique and procedures must be fully described such that field personnel unfamiliar with the site investigation and workplan, could by reading the SAP, obtain representative data. The text must be expanded accordingly.

Response: *Down-hole logging will be performed by an experienced qualified subcontractor. The text states that procedures manuals will be provided by the subcontractor in the field.*

76. <u>Section 3.5. Page 3-4</u>

Comment: The text in this section or an alternate appropriate section must describe leachate wells/lysimeters sampling. The text must be modified to indicate that all wells will be sampled at least twice prior to evaluating site conditions and/or evaluating the need for additional investigative tasks. The text must be expanded as requested.

Response: *Procedures for collection of leachate samples, as discussed earlier, has been described in the appropriate section. Samples will be collected from all wells in the sampling program following completion of the newly constructed wells. A second similar sampling event will be conducted at least three months, but not more than six months after the first event.*

77. <u>Section 3.5.1. Pages 3-5 and 3-6</u>

Comment: a) As indicated previously, the deeper borings advanced for well installation should be sampled continuously.

Response: *a)* *Procedures for core sampling have been clarified. See the text for further details.*

Comment: b) The primary and secondary casing material to be used for the alluvial and bedrock wells has not been identified. All well construction material must be fully described. The text indicates that alluvial wells installed through the landfill material will be cased to the base of the landfill materials or, for upper alluvial wells, the water table, whichever is encountered first. It is not clear why the outer casing for the intermediate and deep alluvial wells will not be set into the silty clay unit in the vadose zone. The text must describe the appropriate rationale.

Response: *b)* *As specified in Section 6.5 of the Work Plan, all wells will be constructed with PVC casing. The text has been expanded to describe conceptual well construction details. This discussion includes specific procedures for drilling in the slope of the berm. See the text for further details.*

Comment: c) The text indicates that the casing will be grouted in place. The grouting procedure must be more fully described. Casing installation must be conducted by pressure grouting procedures. In addition, minimum grout mixture criteria, according to ASTM standards must be presented in the text. The text must be expanded as requested.

Response: *c)* *The text has been expanded to specify that all monitoring wells will be constructed in accordance with appropriate Missouri well construction standards.*

Comment: d) The text indicates that the screen slot size will be 0.010 inch (machine slotted). The screen slot size must be based on sieve analysis of native formation material. In addition the text indicates that standard sieve #12-28 sand will be used to create a filter pack. The grain size distribution must be chosen such that less than 10 percent of the filter pack sand will pass through the chosen screen size and the coefficient of uniformity is less than 2. Sand size must be based on screen size which must be based on grain size analysis of the native formation sediments. The text must be revised accordingly. The installation procedures for the filter pack must be described. The filter pack sand must be installed using a tremie pipe. The text must be modified accordingly.

Response: *d)* *We have propose to confer in the field with EPA, following examination of cores and cuttings to select the appropriate screen size and filter pack material. Potential materials will be standard screen slot between 10 to 20 size and standard, readily available filter material comparable to standard sieve sand near or within the approximate range of #10 to #30.*

Comment: e) The text should be revised to indicate that the casing for bedrock wells will be socketed five feet instead of two feet into competent bedrock.

Response: *e)* *The requested change has been made.*

Comment: f) The text on Page 3-6 indicates that the bedrock well will be completed 20 feet into bedrock. The depth of the well should be based on bedrock characteristics determined in the field. Bedrock characteristics should be evaluated using drilling penetration rates, rig downhole pressure, drilling characteristics ("smoothness of drilling", "bit chatter") rock quality designation (RQD), core break morphology (fracture staining, precipitates, solution pits and channels, clay infilling, insoluble residues), fracture fit ("goodness of fit") and bedding plane parting features, rock matrix characteristics (primary and secondary porosity), losses in drilling fluids and changes in head during drilling. The text should be modified to indicate that well placement will be based on bedrock characteristics, not a predetermined depth.

Response: *f)* *The maximum depth into bedrock for these wells will be 20 feet. The depth of the hole will be determined in the field based upon the referenced bedrock characteristics and consultation with the EPA field representative.*

Comment: g) The text in the fifth paragraph on Page 3-6 indicates that during well development a minimum of 10 to 15 well casing volumes will be removed. There is no discussion of the removal of lost drilling fluids. The text should be rewritten to indicate that 10 to 15 well casing volumes or the volume of water or amount equal to that lost during drilling and well installation (tremie activities), whichever amount is greater, will be removed.

Response: *g)* *The referenced discussion has been added to the text. See the text for further details.*

Comment: h) The procedures of well development presented in the fifth paragraph is incomplete. The text must be expanded to describe whether the screen interval will be surged. In addition, there is no discussion of how the deep wells will be surged. It is doubtful that manual surging will be possible on the deep wells. The text should be expanded to more fully describe pumping activities during development. If a pump is utilized during development the pump should be raised and lowered through the screen interval. The pump should be rest near the bottom of the well near the end of development. The text must be expanded as suggested.

Response: *h)* *The discussion of well development procedures has been expanded. See the text for further details.*

78. Section 3.5.3, Pages 3-7 through 3-9

Comment: a) The text in the first bullet item indicates that standing water will be removed. The text must identify how the standing water will be removed. In addition, the text in this section must identify the minimum length of time between well construction and well sampling. The text must be modified as requested.

Response: *a)* *Procedures for well evacuation have been described in more detail. Wells will be sampled no sooner than 24 hours after development is completed. Development may commence 24 hours after a well is completed.*

Comment: b) The text on page 3-7 indicates that a minimum of three well volumes will be evacuated from the well prior to sampling. The text on Page 3-8 describes determining well casing volume. It should be noted there is significant difference between well casing volume and well volume. The text should provide the equation to be used to determine sand pack volume and casing volume to insure that the proper well volume is removed during sampling.

Response: *b)* *The well volume has been defined as the volume within the casing plus a calculation of volume within the filter pack.*

Comment: c) The text on Page 3-9 should be expanded to describe the minimum information to be recorded in the field logbook/sample collection sheet.

Response: *c)* *This detail has been provided. See the text for further details.*

79. Section 3.5.4, Pages 3-9 and 3-10

Comment: a) The text on Page 3-9 should be expanded to describe the procedures to be performed on water table wells (rising head test only).

Response: *a)* *Falling head slug tests will not be performed on upper alluvial wells.*

Comment: b) The description of slug test procedures as presented on Page 3-10 is incomplete. The text must be expanded so that field personnel unfamiliar with the workplan and procedure could by following the procedures outlined in this document obtain representative data. The text must be modified accordingly.

Response: b) The description of these procedures has been enhanced. See the text for further details.

80. <u>Section 4.2. Page 4-2</u>

Comment: There is no discussion of drilling fluids management. The text needs to identify that drilling fluids will be staged at the site until analytical results are reviewed by EPA.

Response: The procedures for management of waste generated have been described. See the text for further details.

81. <u>Section 5.1, Page 5-1</u>

Comment: This section states that data for each sampling area will be described as a range with a mean value and a standard deviation. This very brief description does not say why this data treatment is considered appropriate. It appears that all the samples analyzed, including the many that are not taken from within the contaminated waste, are to be averaged to obtain a "mean." A range, which will be from some background value to the highest sample found by the sampling method that is used, is very unlikely to be the highest contaminant level to be found in the area. A standard deviation will also be given. Considering the nature of the sampling process, it is not clear what the "mean" of these samples will represent. It will be the mean of the highest-reading samples taken from five-foot intervals in boreholes selected primarily at random from a grid that may or may not coincide roughly with the area of the buried contamination.

The likely result will be a preponderance of very low results, together with "hot spot" results where a sample was taken from the waste itself. Earlier statements suggest that such a distribution would be called a "log-normal" distribution of the data, and used to justify a geometric mean. There is no indication that this is intended at this point. However, this may be the "more precise assumption" mentioned above under Section 4.2.

Response: *A list of possible evaluation techniques have been included. The text states that appropriate evaluation techniques will be applied upon examination of the data. It has been specified that contaminant concentrations will be compared with background concentrations. Typically two times background is found to be an appropriate level.*

82. Field Documentation Forms

Comment: a) The following field documentation forms should be used during the field investigation and should be addended to this section: air monitoring record; equipment calibration record; field activity or daily log; well construction schematic log; in-situ hydraulic conductivity test log (slug test log); location sketch log (e.g., sample, boring location sketch log).

Response: a) The appropriate forms for the matrices to be examined have been included.

Comment: b) The SAP must be expanded to include all field equipment operating manuals and equipment calibration instructions.

Response: b) The text specifies that all appropriate operation and calibration manuals will be available in the field.

Quality Assurance Plan
83. Section 3.2. Page 3-2

Comment: This section states: "An overall completeness rate of 90 percent is generally acceptable and will be the standard applied to this project." The text must provide the rationale for not using 100 percent completeness rate. The text must identify if there are specific difficulties in the sample collection and analyses that are anticipated at West Lake Landfill.

Response: The number of samples for each matrix will be examined to determine an appropriate completeness rate. It has been further stated that failure to achieve the completeness goal will not invalidate the data, but rather only qualify the data.

84. <u>Table 4-1</u>

Comment:	a)	The text must be modified to provide Practical Quantitation Limits (PQLs) for all parameters listed.
Response:	*a)*	*Due to the number of analytes evaluated by the listed methods, it is impractical to list the PQLs for all analytes in the Table 4-1 format. The standard PQLs for the analytes are listed in the standard method references.*
Comment:	b)	The holding time for Soil/Sludge Semivolatile Organic Compounds and Pesticides/PCBs is incorrect. The table must be revised to replace "Extract: 14 days Analysis: 40 days" with "Analysis within 14 days".
Response:	*b)*	*The currently appropriate holding time has been listed.*
Comment:	c)	The holding time listed for the matrices Water/Liquid and Soil/Sludge for Total Priority Pollutant Metals analyses is incorrect for Mercury (Hg). The table must be modified to replace "6 months" with "6 months, Hg-28 days".
Response:	*c)*	*This change has been made.*
Comment:	d)	Water samples collected for radionuclides analyses should be preserved with HNO3 to a pH of <2. In addition, the Holding Time for the matrices Water/Liquid and Soil/Sludge for radionuclides analyses is incorrect. The table should be modified to replace "none" with "6 months".
Response:	*d)*	*This procedure has been discussed further. See the text for further details.*
Comment:	e)	The analytical method listed for Total Petroleum Hydrocarbons is a modified 8015 (81015M) method. The table must be revised to state if this analysis is to include volatiles ("gasoline") and semivolatiles ("diesel") or exclusively for one fraction.
Response:	*e)*	*The table has been revised to state that the analyses will include the full scan of analytes.*

85. Section 7.2 Page 7-2

Comment: a) This section states "Radiological monitoring equipment will consist (of) a scintillation device which will be calibrated at the factory according to the manufacturer's recommendations." The text must provide more detail on the field screening for radionuclides, i.e. what specific scintillation counter, must identify the "cocktail," identify what length of time will be counted and identify the windows. The text must describe how background samples will be collected and evaluated. The text must provide a "decision tree" for the determination of when a sample is considered "clean" and for when a sample is considered "hot."

Response: *a)* *The operation and calibration manual for the device to be used will be provided in the field. The text has been expanded to discuss the determination of background and elevated levels of radiation. See the text for further details.*

Comment: b) The text in the second paragraph must be modified to change the reference from "National Bureau of Standards (NBS)" to "National Institute of Standards and Technology (NIST)".

Response: *b)* *This change has been made.*

86.

Comment: This section states "A qualified chemist from McLaren-Hart will conduct an independent data validation review. It is not clear whether this review will be a Data Validation or Data Review. The text must be clarified. It is not clear whether the chemist is going to follow the "National Functional Guidelines for Data Review". The text must be revised to provide specific criteria the chemist will be using in his/her review. The text must describe how method blank contamination will be qualified. The text must identify the criteria that will be used for the radionuclide review.

Response: *McLaren/Hart will use standard data evaluation procedures to determine that the data from this investigation is of sufficient quality as discussed in the QAPP.*

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1.0 INTRODUCTION

On August 11, 1992, the United States Environmental Protection Agency Region VII ("USEPA") issued a Special Notice for Remedial Investigation/Feasibility Study ("RI/FS") to Rock Road Industries, Inc., Laidlaw Waste Systems, Inc., Cotter Corporation, and United States Department of Energy, together referred to as the "Respondent Group". The Special Notice informed the Respondent Group of potential liability for releases or threatened releases of hazardous substances from portions of the West Lake Landfill, National Priorities List ("NPL") site, pursuant to Section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA"), as amended by the Superfund Amendments and Reauthorization Act of 1986, 42 U.S.C. § 9607. The Special Notice included a draft Administrative Order on Consent ("AOC") and Statement of Work ("SOW") for performance of an RI/FS for Radiological Areas 1 and 2 and areas where contaminants have migrated from Areas 1 and 2 ("Site"). On December 23, 1992, the Respondent Group submitted a Good Faith Offer response which included a revised AOC/SOW and other information in accordance with CERCLA regulatory requirements. Based on subsequent discussion and negotiation between the Respondent Group and USEPA, a final AOC and SOW were completed on December 29, 1992. On March 3, 1993, the AOC/SOW was executed by USEPA Director, Waste Management Division, which initiated the RI/FS process.

This document presents the RI/FS Work Plan for the Site. The definition of "Site" as used herein shall refer to Radiological Areas 1 and 2, including areas where contaminants have migrated consistent with Section IV (Statement of Purpose) of the AOC. The purpose of the Work Plan is to provide the necessary and appropriate information to guide the performance of the RI/FS for the Site. The Work Plan is developed to be consistent with the AOC and SOW, USEPA RI/FS guidance entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (document number USEPA/540/G-89/004 dated October, 1988), and other documents listed in Section 11.0, References.

Based on available information and to the extent practical, the Work Plan presents (1) a comprehensive summary of the pertinent history of the Site, including past operations, disposal practices, and investigative and remedial responses; (2) a summary of potential contaminant sources, chemicals of concern (including radionuclides), and potential contaminant migration pathways; (3) a summary of potential receptors; (4) a conceptual model of the Site including a preliminary characterization of the physical and chemical framework (including radiological component); and (5) potential remedial alternatives appropriate for the Site. From this information, the Work Plan identifies the additional information and data that must be acquired to complete the RI and FS under CERCLA. The RI serves as the mechanism for collecting data to characterize site conditions; determine the nature of the waste; assess risk to human health and the environment; and conduct treatability testing as necessary to evaluate the potential performance and cost of the treatment technologies that are being considered. The RI also supports the design of selected remedies. The FS serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. The objective of the remedial actions will be to ensure protection of human health and the environment.

3.0 PRELIMINARY SITE CHARACTERIZATION

3.1 Physiography and Geological Setting

A map of the West Lake Property is shown on Figure 3-1. A map depicting the topography is shown in Figure 3-2. Radiological Areas 1 and 2 are shown on these Figures and define the Site, as specified by the AOC, SOW, and this Work Plan.

The St. Louis metropolitan area is located at the confluence of the Missouri and Mississippi Rivers and generally consists of Jefferson, St. Charles, and St. Louis Counties, in Missouri. The area lies within two physiographic provinces. The northeastern two-thirds of St. Charles and St. Louis Counties and the extreme northeastern part of Jefferson County, adjacent to the Meramec River, lie within the Dissected Till Plains of the Central Lowland physiographic province. The remainder of the area is part of the Salem Plateau of the Ozark Plateau physiographic province (Miller, et al., 1974).

The Dissected Till Plains is gently undulating, with altitudes ranging from 500 to 700 feet above mean sea level ("MSL"). Though the area was glaciated twice during the Pleistocene era, the morainal topography typical of adjacent glaciated areas is noticeably lacking in this area. The till deposits in this area are thin and dissected due to subsequent erosion following the glaciated periods.

The topography developed in the Ozark Plateau physiographic province in the St. Louis area is classified as sub-mature to mature. The broad flat uplands are generally dissected and most of the divides are narrow and irregular. Altitudes in the Ozark Plateau area range from 650 to 1,000 feet MSL, except in stream valleys where altitudes are from 400 to 650 feet MSL.

The bedrock stratigraphic sequence in the St. Louis vicinity consists primarily of limestone and dolomite. These were deposited, for the most part, in shallow epicontinental seas. Surface exposure of the geologic units, and well data from the area, exhibit disconformities and local unconformities which imply many episodes of emergence, non-deposition, or erosion.

Figure 3-1 Site Map

Figure 3-2 Site Topographic Map

3.2 Regional Geology and Hydrology

3.2.1 Geology

Geologic deposits range in age from Precambrian to Quaternary-Holocene. The Precambrian units are not exposed in the area. A generalized stratigraphic column for the St. Louis area is presented in Table 3-1. Quaternary age deposits consist of recent (Holocene) alluvial deposits, and loess and glacial till deposits from the Pleistocene glaciation. The alluvial deposits range in thickness from 0 to 150 feet. Loess deposits are up to 110 feet thick, and till deposits are infrequent, but do occur in layers up to 55 feet thick.

Underlying the Quaternary deposits are Missourian, Desmoinesian, and Atokan Formations of Pennsylvanian age, which consist primarily of shales, siltstones, and sandstones containing silt and clay. The total thickness of the Pennsylvanian system ranges from 0 to approximately 375 feet.

The Mississippian series, consisting of the Meramecian, Osagean, and Kinderhookian Formations, underlie the Pennsylvanian rocks. These formations consist primarily of limestones with some shales and siltstones. The Meramecian series includes the St. Genevieve Formation (0 to 160 feet thick), St. Louis Limestone (0 to 180 feet thick), Salem Formation (0 to 180 feet thick), and Warsaw Formation (0 to 110 feet thick). The Osagean series consists of the Burlington-Keokuk Limestone, a cherty limestone, and Fern Glen Formation consisting of a red limestone and shale. The Burlington-Keokuk can range in thickness from 0 to 240 feet and the Fern Glen from 0 to 105 feet.

At the base of the Mississippian formations is an unconformity which is underlain by Devonian units comprised of sandstone, limestone, and shale. The Devonian deposits do not exceed a thickness of approximately 100 feet in the area. An unconformity at the base of the Devonian units is underlain by cherty limestone of Silurian age, as much as 200 feet thick. Geologic units of Ordovician age, which can be present in thicknesses up to approximately 2,300 feet, underlie the Silurian deposits. Ordovician deposits are primarily limestone, dolomite and shale with some sandstone. Upper Cambrian age deposits, beneath the Ordovician units, consist of cherty dolomite, siltstone, sandstone and shale. Precambrian igneous and metamorphic rocks underlie the Cambrian units.

Table 3-1 Generalized Stratigraphic Column for St. Louis, St. Charles, and Jefferson Counties, Missouri

3.2.2 Hydrology

3.2.2.1 Groundwater

Aquifers in the St. Louis area most favorable for groundwater development include: Quaternary-age Alluvium; Ordovician-age St. Peter Sandstone, Roubidoux Formation, and Gasconade Dolomite; and Cambrian age Potosi Dolomite. The major alluvial aquifer in the area includes basal parts of the alluvium underlying the Mississippi, Missouri, and Meramec River floodplains. These floodplain alluvial aquifers are typically exposed at the surface and can range in thickness up to 150 feet. The St. Peter Sandstone aquifer lies at a depth of approximately 1,450 feet below ground surface and can be as much as 160 feet thick. This aquifer is documented to be brackish to varying degrees. The average depth to the top of the Roubidoux Formation is approximately 1,930 feet. Thicknesses of this unit in the St. Louis area can range from not present to 177 feet thick. The Gasconade dolomite directly underlies the Roubidoux. The Gasconade and associated Gunter Sandstone occur in thickness up to 280 feet. The Potosi dolomite can be present in thickness up to 325 feet thick and lies at an average depth of 2,240 feet. It should be noted that depth to these formations vary throughout the St. Louis area and may not be present at all in some parts of the area.

Alluvial aquifers are recharged by infiltration of stream water during sustained high river stage and flooding, direct precipitation, and underflow from underlying and adjacent bedrock. The deep bedrock aquifers are recharged directly by surface water in areas where the bedrock strata are exposed or through the alluvium in areas where truncated limbs of deformed bedrock are disconformably overlain by alluvial aquifers. The nearest source of such recharge points are located several miles east of the site. The bedrock and alluvial aquifers account for 1 and 2 percent of the total pumpage, respectively (Miller et al., 1974). These aquifers are not utilized for the St. Louis Metropolitan Area water supply. Only private water wells drain from the alluvial and bedrock aquifers (See Section 3.4 for further details).

3.2.2.2 Surface Water

Three major rivers, the Mississippi, Missouri, and Meramec, pass through the St. Louis area, and supply nearly all of the water used in the St. Louis area. Other, minor rivers and streams in the area are tributaries to these three rivers. In addition, a few minor surface water bodies (lakes) exist in the region. These rivers and tributaries drain the surface runoff from the region. The Mississippi River flows along the eastern Missouri state border. The Missouri River flows through the northern portion of the St. Louis metropolitan area and empties into the Mississippi north of St. Louis. The Meramec River flows along the southern portion of the metropolitan area and empties into the Mississippi south of St. Louis.

3.3 Local Geology and Hydrology

3.3.1 Geology

3.3.1.1 Unconsolidated Sediments/Overburden

The West Lake Property is located on the eastern edge of the historic Missouri River Valley at the transition between the alluvial flood plain to the west and the loessial bluffs to the east. The approximate location of the historic edge of the alluvial valley is shown on Figure 3-1. Areas 1 and 2, the treatment pond, and the stormwater retention ponds are all located within the flood plain and are underlain by alluvium. The majority of the former limestone quarry is located east of the flood plain and was, prior to quarry operations, covered by a thin veneer of loess. Expansion of quarry operations during the 1960's and 1970's was in a westerly direction and encroached onto the alluvial flood plain.

The Missouri River alluvium consists of clay, silt, sand, and gravel admixtures. Generally, the uppermost sediments are characterized as silt and clay which are derived from periodic flooding of the Missouri River (overbank deposits).. Below a depth of 5 to 10 feet, the sediments are generally coarser grained and consist primarily of sand and gravel (point bar deposits). Due to the energy regime in which these fluvial sediments were deposited, the upper silt and clay layer is expected to be laterally persistent; the sand and gravel are expected to occur as discontinuous lenses of variable thickness.

The overall thickness of the alluvium varies from zero feet at the contact with the loess to approximately 100 feet beneath the center of the Missouri River Valley. Geologic cross sections illustrating the lithology of the alluvium are shown on Figures 3-4 through 3-7. The traces of the geologic cross sections are shown on Figure 3-3. The lithologic data used to prepare the cross sections were obtained from previous investigation reports for the West Lake property (see Appendix B.

Figure 3-3 Cross-Section Locator Map

Figure 3-4 Subsurface Fence Diagram A to A'

Figure 3-5 Subsurface Fence Diagram B to B'

Figure 3-6 Subsurface Fence Diagram C to C'

Figure 3-7 Subsurface Fence Diagram D to D'

The loess is an aeolian (windblown) deposit and consists primarily of silt sized rock particles. The loess was deposited during the Pleistocene glacial epoch as a blanket over much of Missouri and Illinois. The bluff and hills east of the site are composed of loess. The loess is reported to be as great as 80 feet thick beneath these hills.

Unconsolidated materials also present on site include man-made deposits of crushed rock and soil fill, and landfill debris.

3.3.1.2 Bedrock

The uppermost bedrock beneath the Site is composed of the Mississippian age limestone of the Meramecian series. This series consists of the St. Louis and Salem Formations and extends to a depth of approximately 250 feet below ground surface (approximately 190 feet MSL). The St. Louis and Salem Formations are composed primarily of limestone. These limestones are dense, bedded, and contain a minimal amount of chert. However, intermittent layers of abundant chert nodules are observed in the formations. The Mississippian age Warsaw Formation underlies the St. Louis and Salem Formations. This formation consists of slightly calcareous, dense shale which grades into shalely limestone. The typical thickness of this formation is 40 feet. Bedrock strata beneath the Site are nearly horizontal, with a reported dip to the northeast of approximately 0.5 degree from horizontal. The attitude of the bedrock is reversed by the Florrisant Dome located approximately 5 miles east of the Site (Martin, 1966). Quarry operations extended from the ground surface to the top of the Warsaw Formation.

Figure 3-8 shows the bedrock surface contours, based upon information obtained from boring logs. This contour map was developed using computer-based interpolation of available data and shows a steepening of the contours near the edge of the alluvial valley and a flattening of the contours in a westerly direction toward the center of the valley. The contours depicted in Figure 3-8 represent a general understanding of the bedrock surface in the area. The bedrock contours in the former quarry are projected to illustrate the probable bedrock surface, if quarrying within the former quarry had not occurred. This figure provides a preliminary basis for placement of sample points and boring/well depths, and other field activities.

Figure 3-8 Limestone Bedrock Surface Map

The upper surface of the limestone bedrock is irregular and pitted as a result of karst[2] activities (Lutzen and Rockaway, 1971). Karst activity within the limestone is reportedly limited, based upon visual observation of the quarry walls. Karstic development is reported to be limited to widening of joints and bedding planes near the bedrock surface.

The limestone immediately adjacent to the former quarry has been pressure grouted to limit groundwater inflow into the regulated landfill which now occupies the pit. Based on visual evaluation of the quarry walls, prior to the operation of the landfill, only minor groundwater seepage was observed on the walls of the quarry. Where seepage was observed, it was within open fractures and along bedding planes.

3.3.2 Hydrology

3.3.2.1 Groundwater

Fifty-six monitoring wells have been installed in and around the Site, and 46 of these wells are reported to exist. All of the monitoring wells are completed within the alluvium and are identified as shallow, intermediate, or deep wells based on completion depths. The deep monitoring wells were drilled to encounter bedrock and many of the wells were terminated at, or immediately below the contact. Table 3-2 summarizes the well construction details for the monitoring wells.

Groundwater is present within the valley alluvium and the underlying limestone bedrock. Based on available data, both of these water-bearing units are under unconfined aquifer conditions. Groundwater in the alluvium generally occurs at a depth of 10 feet or less below the natural ground surface. The alluvium is fully saturated from the top of groundwater surface to the top of the underlying limestone. There is no confining bed present along the contact with the underlying limestone.

Limited groundwater is present within the limestone bedrock. In the southern portion of the Site, the groundwater present originates from surface water infiltration from the overlying loess. Within the central and northern portion of the Site, the groundwater originates primarily from the overlying alluvial aquifer. Water levels in deep wells which are

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[2] Karst activity is generally the dissolution of the rock matrix by groundwater resulting in the enlargement of matrix pores and voids.

Table 3-2 Well Construction Data

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completed within the upper portion of the limestone bedrock generally have water level elevations which are hydrostatically similar or slightly lower than the adjacent shallow and intermediate depth monitoring wells.

The alluvium has a high hydraulic conductivity, especially in the lower portion of the aquifer where sands and gravels predominate. The hydraulic conductivity of the limestone bedrock is significantly less than the alluvium, and is expected to be several orders of magnitude lower. Groundwater flow within the limestone is essentially limited to open fractures and along bedding planes, as evidenced by visual evaluation of the exposed limestone in the quarry walls. Karst solution features are limited to the upper portion of the limestone and their influence on groundwater flow is therefore limited.

Groundwater elevations vary on a seasonal basis and generally, fluctuate between elevations of 430 and 438 feet MSL. Water level rises are associated with periods of high precipitation. Coincident with the precipitation is a rise in the Missouri River stage. Figure 3-9 illustrates the general similarity of the Missouri River stage and groundwater elevations in selected monitoring wells. Appendix C lists the daily river stage data for the St. Charles gauging station for the years 1970 through 1992.

The overall groundwater flow direction beneath the Site is to the northwest. Figures 3-10 through 3-15 present groundwater contour maps for data collected on March 30, 1985, and August 8, 1985, for the shallow, intermediate, and deep monitoring wells. Groundwater contour data show essentially the same overall pattern within all three well completion depths.

Review of the groundwater contour maps suggests that a groundwater trough is present beneath the Site. This trough is oriented in a northwesterly direction. Groundwater flow is generally directed towards the center of the property and exits on the north, beneath Area 2. This interpretation is based on limited data. The August 1985 Intermediate well data (Figure 3-14) represents the most comprehensive set of groundwater data available and is the basis for contouring of the groundwater in the other well completion intervals and contouring of the March 30, 1985 data. Based on the available data, there is no reason for assuming that the groundwater flow in the shallow and deeper alluvial aquifers do not conform to this general groundwater flow pattern. Additional water elevation data are necessary to confirm groundwater flow direction within each of the three depth intervals. The above interpretion provides the basis for the tentative monitoring well locations

Figure 3-9 Missouri River Stage Versus Well Water Level

Figure 3-10 Groundwater Contour Map Shallow Wells March 30, 1985 Data

Figure 3-11 Groundwater Contour Map Intermediate Wells March 30, 1985 Data

Figure 3-12 Groundwater Contour Map Deep Wells March 30, 1985 Data

Figure 3-13 Groundwater Contour Map Shallow Wells August 8, 1985 Data

Figure 3-14 Groundwater Contour Map Intermediate Wells August 8, 1985 Data

Figure 3-15 Groundwater Contour Map Deep Wells August 8, 1985 Data identified in section 6.4.1 of this Work Plan. Water level data for individual wells are included in Appendix D.

There are several possible explanations for the groundwater trough. Two likely explanations are as follows:

- Drainage ditches and ponds surround the perimeter of the property. It is possible that these surface water bodies are recharging groundwater. If groundwater recharge mounds are present beneath these features, then you would expect a groundwater trough similar to that observed.

- The regulated landfill is located in the southern portion of the Site. The landfill is located in the former limestone quarry, and the limestone immediately adjacent to the quarry was pressure grouted prior to construction of the landfill. If the former quarry is acting as a non-permeable mass (groundwater obstruction), then groundwater flow will diverge as it approaches the quarry. On the downgradient side of the quarry, groundwater flow will converge. This will result in a groundwater trough similar to that observed.

It is reasonable to expect that a combination of both of these explanations are the cause of the groundwater trough. The groundwater data indicate that groundwater recharge is occurring from the treatment pond and stormwater retention pond which are located on the west. Data also suggest that surface water runoff and localized ponding on the property may be a source of groundwater recharge.

The groundwater gradient as determined from the contour maps range from 0.0004 to 0.0019 feet/foot. Groundwater gradients are greatest in the shallow and intermediate depth wells. The August 1985 groundwater gradients are slightly steeper than those determined from the March contour data.

Surface exposure of groundwater can occur in the form of seeps and springs. Based on review of previous investigation reports and correspondence, no springs are present on the property. Seeps have been locally observed on the walls of the limestone quarry, and also near the toe of the berm on the west side of the property. The seeps within the quarry have been mitigated by the pressure grouting. Future seeps in the berms can be expected to occur in areas of poor surface drainage and localized ponding of rainwater.

3.3.2.2 *Surface Water*

Precipitation that falls on the historic Missouri River floodplain generally infiltrates the soil rather than running off the surface. The Missouri River floodplain is relatively flat and sediments have an infiltration index[3] of 3.5 inches (Miller, Emmett, et al., 1974). Streams present within the floodplain are those that originate in the surrounding uplands.

Drainage patterns within the historic flood plain surrounding the Site have been altered by flood control measures taken to protect the nearby commercial development and by the drainage of local swamps and marshes. Prior to these alterations, Creve Coeur Creek passed just south of the West Lake Property. This Creek has since been redirected to discharge to the Missouri River upstream of St. Charles. The old channel, south of the West Lake Property, still carries some water, and empties into the Missouri River 28 miles upstream from its confluence with the Mississippi River (mile 28). Near the Site, this channel is usually dry (UMC).

The present channel of the Missouri River lies about 2 miles west and northwest of the Site. Historic land surveys indicate that 200 years ago the channel was several hundred yards east of its present course closer to the Site (Reitz and Jens, 1983; UMC report). The Missouri River has a surface slope of 0.00018 feet/foot (Long, 1981; UMC report). The reference river stage at St. Charles (mile 28) is 413.7 feet MSL. Average discharge for the Missouri River is 77,300 cubic feet per second ("cfs"), with a typical maximum flow of 101,000 cfs for the period April through July and a typical minimum flow of 40,300 cfs in January and December.

The city of St. Charles draws water from the Missouri River at an intake located on the north bank near mile 29. The St. Louis County, North County plant draws water from intake located at mile 20.5; approximately 7.5 miles downstream of the Site.

Review of historic aerial photographs of the Site show several surface water drainages were present on the northern portion of the property prior to development. These drainages are oriented in a north to northeasterly direction and are directed toward the surface water body located north of Area 2. Portions of these drainages are now covered by Area 2.

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[3] A soil infiltration index is generally, the amount of rainfall that will infiltrate the soil under given conditions before run-off occurs.

The aerial photographs show also that the shape of the pond north of Area 2 has changed over time. The improvements most-likely occurred concurrent with the excavation of a pond on the neighboring property located on the opposite side of St. Charles Rock Road. Figure 3-16 is an aerial photograph of the Site with an overlay showing the location of the former drainages, the improved pond, and the current topography on the Site.

Quarry and landfill operations on the West Lake property have influenced surface water runoff patterns, and in many instances have led to localized ponding of rainwater. Figure 3-17 is a map of the property showing the drainage pattern and the direction of surface water runoff. The figure is based on review of the Site topographic map.
As can be seen from this figure, drainage from the central portion of the Site is directed to the south toward the former quarry. Drainage along the perimeter of the property is directed away from the center of the Site toward the perimeter property lines. Drainage from Area 1 generally flows in an easterly direction towards St. Charles Rock Road. Drainage from Area 2 primarily flows in a northerly direction toward the Ford property. A portion of Area 2 drains toward the former quarry. Several closed depressions are apparent in Area 2 and lead to ponding of rainwater.

Areas 1 and 2 are covered with a layer of clean soil. Surface rainwater runoff is not expected to mobilize contaminants which may be present beneath these areas. Based on site topography, a severe and prolonged rainfall may lead to erosion of the soil cover in the lower elevations of Area 1. Erosion of the soil cover and mobilization of the underlying contaminants may potentially occur if the soil cover is not of adequate thickness.

Ponding of rainwater on the ground surface at the top of a berm may lead to the saturation of the underlying soil, and ultimately a slope failure. Ponding and surface water infiltration under the proper conditions may also lead to the development of seeps along the face, or the toe of the slope. If infiltration occurs in the immediate vicinity of the former drainages which are present beneath Area 2, then the former drainages may act as a potential conduit for more rapid movement of the contaminants, and discharge into the pond north of Area 2.

Figure 3-16 Aerial Photograph of the Site Showing Former Drainages and Pertinent Site Features

Figure 3-17 Aerial Photograph of the Site Showing Surface Drainage and Direction of Surface Water Runoff

3.4 Groundwater Use In the Area

There are no public water supply wells which draw from the alluvial aquifer in the vicinity of the Site. The number of private water supply wells within the vicinity of the Site is not clearly defined.

In 1989, Foth and Van Dyke prepared a report of groundwater use in the vicinity of the Site. This report included an examination of the occurrence and use of groundwater wells in the vicinity of the Site. Twenty-six private water supply wells have been identified within a 3-mile radius of the Site. No private supply wells used for drinking water have been found within a 1-mile radius of the Site. The closest well is located approximately 2,500 feet northeast of the Site. Water from this well is apparently used for irrigation purposes only (Foth and Van Dyke).

According to the Missouri Department of Health's Preliminary Health Assessment of the West Lake Landfill, it is believed that only one private well in the vicinity of the landfill is used as a drinking water supply. This well is approximately 1.5 miles north-northwest of the Site. In 1981, analyses showed water in the well to be fairly hard (natural origins) but otherwise of good quality.

The RI will determine whether the private wells are relevant to the Site.

3.5 Landfill Design Information

Landfill operations at the West Lake Property have occurred in two distinct phases. From its beginning until 1974 landfill operations were unregulated. In 1974 operation of the Unregulated Landfill was halted. Subsequently, permits were received for operation of the Regulated Landfill in another portion of the West Lake Property. The Site is located within the Unregulated Landfill.

The Regulated Landfill consists of cells designed in accordance with permit conditions. Waste is deposited in these cells and covered every day with compacted soil. The Regulated Landfill includes a leachate collection and treatment system and a gas collection system. All operations of the Regulated Landfill are directed by the MDNR permit. The leachate treatment effluent is discharged to St. Louis Metropolitan Sewer District ("MSD"). Operation of the Regulated Landfill is discussed above in Section 2.

Engineering design information is unavailable for the Unregulated Landfill. Waste material may have been placed directly on the native ground surface. Information on the landfill operation indicates that the waste was periodically covered with soil to minimize rodent and odor problems. Previous reports have indicated that both areas containing radioactive material are unlined and above the natural ground surface.

3.6 Ecology

While the ecological system at the Site may change over time, previous ecological assessments of the West Lake Property are summarized as follows. The ecological system, at the West Lake Property is associated with:

- Moist bottomland and farmland adjacent to the perimeter berm;
- Poor quality, drier soils on the upper exterior and interior slopes of the berm;
- An irregular ground surface associated with the inactive portion of the landfill; and
- Aquatic ecosystems present in low spots on the ground surface and adjacent surface water.

Generally, the natural systems present are influenced by operations at the West Lake Property, and are common to similar areas in east-central Missouri. These systems are located in a corridor along the perimeter berm, from near well Site 75 (Figure 3-1), along Old St. Charles Rock Road, clockwise to the main entrance of the landfill, to near well No. 68, along St. Charles Rock Road. The following observation and descriptions have been summarized from a previous NRC report.

Along Old St. Charles Rock Road, the flora on the bottom and lower slope of the berm includes silver maple, boxelder, oak, sycamore, green ash, and eastern cottonwood trees. At the corner, between wells 59 and 60 (Figure 3-1), large silver maple and boxelder trees form a dense stand in the moist soils at the base of the berm. The density of these trees declines on this slope extending toward the north. The extension of this slope toward the northwest is dominated by a dense willow-like thicket in which a few eastern cottonwoods and a hawthorn tree have been established. From the northwest corner of the landfill to the east, along St. Charles Rock Road, the exterior slope of the berm is dominated by dense stands of small and large eastern cottonwoods. The ground cover along these exterior slopes consists of grasses, forbs, plants common to disturbed areas, seedling cottonwoods, and shrubs. A grass groundcover continues from the limit of the trees of the area around the main entrance of the landfill. This vegetation contributes to the partial stabilization of the steep exterior slopes.

The somewhat drier top and the short, interior slope of the berm, includes prairie grasses such as bluestem. Depressions in the irregular surface of the inactive, Unregulated Landfill allow water to collect and tall grasses, foxtail, and plants characteristic of disturbed areas are replaced by characteristic wetland species. Young eastern cottonwoods are established at several of these depressions.

Common animals were observed associated with these habitats. Cottontail rabbits were encountered most frequently. Coyote feces containing rabbit fur also were observed. Small mammals (rodents) were not seen but could be present in these areas. Large ungulates also were not sighted, but tracks and feces of white-tailed deer have been observed.

Few birds were observed early in the spring. Some migratory passerines may utilize the surface vegetation and berm thickets for nesting, cover, and feed later in the season. It is also possible that waterfowl could utilize the permanent ponds on the landfill and adjacent to St. Charles Rock Road. Scaup and mallards were observed on the lagoon which serves as part of the Regulated Landfill waste water treatment facility.

Small puddles contained characteristic common aquatic invertebrates and at least two species of amphibians. Snails, an isopod (Asnellus), cyclopoid copepods, and cladocerans were observed in these small puddles. Aquatic insect larvae were not observed. A bullfrog tadpole and audition of spring peepers, were observed. No fish were observed in these puddles on the West Lake Property. The only reptiles observed were the water snake and garter snake. (NRC 40-8801).

The Missouri Department of Conservation ("MDOC") reports 25 amphibian, 47 reptilian, 29 mammalian, and 299 avian species in the regional area of St. Charles County (Argonne National Laboratory). Many of the terrestrial vertebrates found within this area are widely distributed species. The MDOC has recorded more than 105 species of fish in the regional area, but, as stated above, no fish appear to exist near the Site (MK-Ferguson Company and Jacobs Engineering Group).

3.7 Climatology

The climate at the Site is typical of the midwestern United States with a somewhat modified continental climate that has four distinct seasons. Winters are generally not severe with the first frost usually occurring in October and freezing temperatures generally not persisting past March. Records since 1870 show that temperatures drop to zero (0°F) or below an average of two or three days per year. Temperatures remain at or below freezing (32°F) less than 25 days in most years. Average snowfall per winter season is slightly greater than 18 inches. Snowfall of an inch or more is received on five to ten days in most years. Record snowfall accumulation over the past 30 years was 66.0 inches recorded during the 1977-78 winter season.

Summers in the St. Louis area are hot and humid. The long-term record (since 1870) indicates that temperatures of 90 degrees Fahrenheit or higher occur on about 35 to 40 days per year and that extremely hot days of 100 degrees Fahrenheit or higher generally occur no more than five days per year.

Normal annual precipitation based on records dating back to 1871 is a little less than 34 inches. The three winter months are usually the driest, with an average total of approximately 6 inches of precipitation. The spring months of March through May are the wettest with normal total precipitation of just under 10.5 inches. Thunderstorms occur normally on 40 to 50 days per year. Usually a few of these storms can be classified as severe with hail and damaging wind during any given year. Tornadoes have occurred in the St. Louis area. Average relative humidity is 68 percent with humidities over 80 percent common during the summer months. Normal monthly precipitation, measured at Lambert International Airport, is presented in Figure 3-18.

Wind direction during the period of December through April is generally from the northwest and west-northwest. Wind direction throughout the remainder of the year is from the south. The National Oceanic and Atmospheric Administration ("NOAA") gauging station for the St. Louis area is at Lambert Field International Airport located approximately 3.7 miles east of the Site. Differences in topography between Lambert Field and the Site may result in the

Figure 3-18 Normal Monthly Precipitation for St. Louis Lambert International Airport actual wind direction at the Site being slightly skewed in a northeast-southwest direction parallel to the Missouri River valley (NRC 40-8801 and NOAA).

3.8 Chemical Occurrence

Following is a summary of the data regarding the occurrence of priority pollutant and radioactive chemicals in and around the Site. A preliminary evaluation of this data is discussed in Section 4.

3.8.1 Soil/Sediment

3.8.1.1 Organic/Inorganic

Appendix E lists the detected chemical constituents in soil and sediment samples collected at the Site and surrounding areas.

There have been very few soil and sediment samples analyzed to date for organic and inorganic chemical constituents. Soil samples taken west of the Site had total petroleum hydrocarbons ("TPH") levels ranging from 5.1 to 14.9 mg/kg. There were no detectable levels of pesticides, polychlorinated biphenyls ("PCBs"), herbicides or cyanide in any of the samples. Metals detected in these samples did not vary significantly from levels observed in a sample chosen to represent background conditions. Low level concentrations (10 to 50 ppb) of several semi-volatile organic compounds were detected in surface composite samples. Their presence was attributed to the sampling technique, which involved mixing the composite in a resealable plastic bag. Plastic bags of this type often contain residual, low level semi-volatile organic chemicals. The sediment samples likewise contained low level semi-volatiles (10 to 19 ppb) which can be attributed to the sampling technique (Dames & Moore). Analyses of soil taken from the Site have focused on the levels of barium, sulfate, and zinc, based on the nature of the material disposed at the Site.

3.8.1.2 Radiological

Appendix F lists the radiological analysis of soil and sediment samples collected at properties surrounding the Site.

As part of their Phase II Investigation, Dames & Moore took unbiased, biased and composite soil and sediment samples from an area adjacent to the Site, to the west. All unbiased and composite soil samples collected randomly within the 23 acre area of investigation, were found to have radionuclide concentrations similar to those measured in samples representing ambient or background conditions.

Biased soil samples were taken from two distinct areas, not to be confused with the Radiological Areas 1 and 2, previously identified as the Site. The two biased samples for this study were taken outside the West Lake Property just south and west of the northwest berm surrounding Radiological Area 2. In the first area, the major nuclides identified as significantly above background were Th-230, Ra-226, U-234, and U-238. In the second area, the analytical parameters and major nuclides identified as present in concentrations above background were gross alpha, gross beta, Th-230, Ra-226, U-234, and U-238. Reanalysis confirmed these results for both areas. These elevated radionuclide levels outside the Site seem to be caused by surface water erosion of the berm adjacent to this area.

Dames & Moore also took biased soil samples for their Phase III Radiological Assessment in the same areas as their Phase II work outside of Radiological Area 2. The radionuclides identified by the soil analyses were Ra-226 and U-238. Ra-226 was found in all samples analyzed at concentrations above the level considered as background for Ra-226 of 1 pCi/g. The highest concentration of Ra-226 found was 690 pCi/g. This sample was characterized by a whitish granular material also observed in samples from the southern portion of the Dames & Moore study area. One biased soil sample, collected in the southern area, from a depth of 24 to 30 inches, contained a concentration of uranium of 5.9 pCi/g.

Comparison of results from sediment samples to those of background soil samples collected for Phase I and II showed that all radiological concentrations observed in sediment were less than or equal to the corresponding background concentrations with the exception of one gross alpha result (Dames & Moore).

RMC analyzed a total of 61 surface soil samples for gamma radiation activity. The samples were collected in and around the Site. Samples were normally stored ten to fourteen days to allow ingrowth of radium daughters. Concentrations of U-238, Ra-226 (from Pb-214 and Bi-214), Ra-223, Pb-211 and Pb-212 were determined for each sample. In all samples, only uranium and/or thorium decay chain nuclides and K-40 were detected. Background samples taken outside of the West Lake Property were on the order of 2 pCi/g for Ra-226. Samples taken in and around the Site ranged from about 1 to 21,000 pCi/g of Ra-226, and from less than 10 to 2,100 pCi/g of U-238. In those cases where elevated levels of Ra-226 were detected, the concentrations of U-238 were generally lower by a factor of 2 to 10. In cases of elevated sample gamma radiation activity, daughter products of both U-238 and U-235 were found.

RMC found that in general, surface activity was limited to Radiological Area 2 of the Site, as indicated by surface beta-gamma measurements. Only two small regions in Radiological Area 1 of the Site showed contamination, both located near the access road. Soil samples taken show that all samples contained Th-230. They found the concentration ratio of Th-230 to Ra-226 (as Bi-214) was approximately 20:1, which indicates an "enrichment" of thorium in these residues (RMC).

RMC also performed a subsurface soil analysis. Subsurface contamination was assessed by extensive logging of holes drilled through the landfill at locations thought to contain radioactive material. Each hole was scanned with a 2-inch by 2-inch NaI (Tl) detector and rate meter system for an initial indication of the location of subsurface contamination. Based on the initial scans, certain holes were selected for detailed gamma logging using an intriusic germanium ("IG") detector and multichannel analyzer ("MCA").

Cross sections of subsurface were taken through Radiological Areas 1 and 2. Figure 3-19 shows the location of these cross sections. Figure 3-20 for Radiological Area 1 and Figure 3-21 for Radiological Area 2 shows the extent of subsurface contamination based on auger hole measurements (Figure reference: RMC, NUREG/CR-2722). It must be noted that the evaluation of radionuclide occurrence presented in these figures is based upon extrapolation of measurements using assumptions of radionuclide decay and ratios. This information is provided as presented by RMC and is included to provide historical background. The investigation defined by this Work Plan will determine the horizontal and vertical extent of radionuclide occurrence and the relative and actual concentrations of the various radionuclides.

Figure 3-19

Figure 3-20

Figure 3-21

3.8.2 Groundwater

3.8.2.1 Organic/Inorganic

Table 3-3 summarizes the chemical constituents detected in the groundwater collected from wells around the Site. Appendix G lists the individual groundwater sample analyses for priority pollutant chemical constituents. Appendix H lists individual groundwater sample analyses for various other physical and chemical parameters. Samples were taken by different investigators and were analyzed for different suites of analytes. Samples were obtained upgradient, downgradient and around the perimeter of the Site.

BMD performed a hydrogeological investigation of the Site. As part of this investigation, BMD analyzed well samples for chemical constituents. The only volatile organic priority pollutant chemical detected, in two separate sampling events by BMD, was methylene chloride. The concentration distribution of this chemical among the analyses performed was irregular. In general, the wells around the Site showed low concentrations of methylene chloride (from 6 to 12 ug/l). However, on only one occasion well D-83 was shown to contain methylene chloride at a concentration of 55 ug/l. This concentration is not consistent with others from the same well at other times or with concentrations measured in adjacent wells. Methylene chloride is a frequent contaminant of laboratory analyses.

BMD found that the distribution of organic and inorganic constituents did not follow a defined pattern. Generally, the distribution of dissolved metals also showed no distinct pattern. Concentrations of metals in downgradient wells did not differ significantly from the concentrations observed in upgradient wells.

In their Phase II report, Dames & Moore found that two volatile organic compounds ("VOCs"), methylene chloride and acetone, were present in low concentrations in virtually all groundwater samples tested. These components are frequent laboratory contaminants and were detected in the method blank during sampling.

Table 3-3 Compilation of Priority Pollutant Detected Constituents in Groundwater around the Site

2 pages

2

3.8.2.2 Radiological

Table 3-4 summarizes the radiological analysis of groundwater collected at the Site and surrounding properties. Appendix I lists the individual groundwater sample analyses for radiological constituents. Samples were taken by different groups, at different times, and analyzed by different laboratories. Many times, only gross alpha and beta values were determined.

During Dames & Moore's Phase II investigation of the property to the west of the Site, they sampled monitoring wells 101 through 107, which border the west side of the Site. All results for filtered samples were below USEPA drinking water standards for gross alpha (15 pCi/l), gross beta (50 pCi/l), and Ra-226 + Ra-228 of 5 pCi/l. All unfiltered samples met these criteria, except for the gross alpha values reported for wells 103, 105, 106, and 107. The gross alpha values reported for these unfiltered samples are also of secondary importance since the sum of the individual radionuclide concentrations do not verify the gross alpha values.

Dames & Moore also performed a radiological assessment of the property to the west of the Site. They once again sampled monitoring wells 101 through 107. Review of the isotopic results from this 1991 Phase III Radiological Assessment for the filtered and unfiltered samples showed no evidence of the target nuclides Ra-226, Th-230 and U-238. Only 4 of 16 samples showed detectable Ra-226 concentrations, all of which were near the background level of 1 pCi/l (1.1 to 1.6). Th-230 was detected in five samples. Concentrations found ranged from 1.1 to 2.3 pCi/l. These values are near background values.

U-238 concentrations ranged from 1.1 to 3.3 pCi/l and were detected in 10 of the 16 samples. The U-238 concentrations are within normal, area, background levels for U-238 in groundwater.

The water samples analyzed showed no evidence of groundwater infiltration of radioactive material originating from the Site as characterized by the presence of Ra-226, Th-230, and U-238. These data are similar to the results of groundwater sampling and analysis performed for the Phase II Investigation (Dames & Moore). RMC collected a total of 37 water samples during the fall of 1980 and the spring and summer of 1981. None of the alpha activities measured in these samples exceeded the maximum permissible concentration for Ra-226 (the most prevalent radionuclide) in water, for an unrestricted area (RMC).

Table 3-4 Summary of Primary Radiological Analyses in Groundwater

Figures 3-22 and 3-23 show the detection of gross alpha, gross beta, and total radium in monitoring wells from samples taken in 1985 and 1986, and 1990 and 1991, respectively. It is noted that the data and evaluations presented herein are those of the original generators and are included to provide historical background. The results of the investigation described in this Work Plan will be evaluated to determine the occurrence of radionuclides in groundwater.

3.8.3 Vegetation

In the "Radiological Survey of the West Lake Landfill" conducted by Radiation Management Corporation, a vegetation analysis was conducted. It included weed samples from on-site locations and farm crop samples (winter wheat) from the northwest boundary of the landfill. RMC chose this location due to possible run-off from the fill into the farm field. The analysis showed no elevated activities in these samples (RMC, 1982).

3.8.4 Leachate

No direct samples of leachate have been collected or analyzed for radioactivity. RMC collected samples of leachate water from the impoundments used to treat leachate from the Regulated Landfill. Isotopic analysis of these samples indicated that all the beta activity could be attributed to K-40 which is a naturally occurring radioactive material (RMC).

3.8.5 Surface Water

Typically, surface water does not occur at the Site. Surface water occurs intermittently in areas around the Site associated with storm events and larger retention areas. Surface water samples were taken as part of the Radiologic Survey of the Site by RMC. Samples were taken from surface ponds, standing water, runoff ditches, and from the Missouri River. One sample exceeded the USEPA gross alpha activity guidelines for drinking water. This sample was taken from standing water in the north-central portion of Radiological Area 2, north of the current location of monitoring well S-61.

Figure 3-22 Radionuclides in Groundwater, 1985 and 1986

Figure 3-23 Radionuclides in Groundwater, 1990 and 1991

3.8.6 Air

In 1980, RMC collected measurements to determine the levels of airborne radioactivity. The isotopes examined were Ra-226, Ra-224 and/or Ra-223 which decay to Rn-222, Rn-220 and Rn-219. Since it was known that the buried material consisted partially or totally of uranium ore residues, the sampling program concentrated on measuring radon and radon daughters in the air. Two methods were used: the first was a scintillation flask method for radon gas and the second was analysis of filter paper activity for particulate daughters. Charcoal canister samples were gathered at 19 locations over a three-month period. Results from this method show levels ranging from 0.3 to 613 pCi/sq.m-s. The charcoal canisters and accumulators were placed in essentially the same location on certain occasions for duplicate sampling. The results of this side-by-side study show generally good correlation between the two methods.

Grab samples were taken using an accumulator method. Radon flux levels ranged from 0.2 pCi/sq.m-s in low background areas to 868 pCi/sq.m-s in areas of surface contamination.

A set of ten-minute, high volume, particulate air samples were taken to determine both short-lived radon daughter concentrations and long-lived gross alpha activity. The highest levels were detected in November 1980 in the north-central portion of Radiological Area 2.

In addition, five, 20-minute, high volume air samples were taken and counted immediately on an IG gamma spectroscopy system. The purpose of these analyses was to detect the presence of Rn-219 daughters. The concentration of Rn-219 daughters ranged from 6E-11 uCi/cc to 9E-10 uCi/cc.

4.0 PRELIMINARY EVALUATION AND CONCEPTUAL MODEL

This section presents an evaluation of the characteristics of and the data collected at and around the Site. This evaluation includes a discussion of known and suspected sources of contamination, types of contamination identified or suspected, the media and pathways of contaminant migration, and known or potential human or ecological receptors. The conceptual model of the Site which is presented in this section will guide the determination of additional investigation necessary at the Site. It will also assist in the identification of potential remedial actions which may be appropriate at the Site.

The areas of the Site that are addressed by this RI/FS work plan are two landfill deposits which have been designated as Areas 1 and 2. Landfill debris was reportedly placed below ground surface in Area 1, while in Area 2 the debris was placed on the native ground surface. The depth of the landfill in Area 1 is not documented, but based on information contained within the files, a portion of the former quarry underlies the Southern most portion of this area (Elbring Co., 1973). The ground surface at both of these areas was unprepared prior to placement of the landfill debris. The landfill in Area 1 extends approximately 30 feet above ground surface, and 50 feet above ground surface in Area 2.

The Regulated Landfill at the West Lake Property is operated under a permit, with provisions for placement and cover, containment cells, and a leachate collection and treatment system. Therefore, this portion of the West Lake Property is not considered a potential source of contaminants at the Site.

4.1 Potential Chemical Sources

In 1973, approximately 8,700 tons of radioactively contaminated barium sulfate ($BaSO_4$) was mixed with approximately 39,000 tons of soil and the mixture was placed at the Site. The source and characteristics of this soil are not well documented. Furthermore, the degree of mixing of these components is not well characterized. This material is assumed to be the source of radiologic contamination at the Site. The approximate extent of this material (Areas 1 and 2) is illustrated on the site location map, Figure 3-1. The results of the planned remedial investigation will provide more specific information regarding the types, concentrations, and distribution of contaminants at the Site.

Prior to 1973, disposal at the West Lake Property was unregulated. Demolition and municipal waste material has been disposed at the Unregulated Landfill. Information exists which has been interpreted by USEPA to suggest that industrial waste has been deposited at the Site. Therefore, the sources of concern at the Site appear to be primarily the radioactively contaminated soil mixture and other material disposed in the former, Unregulated Landfill.

4.2 Potential Chemicals of Concern

The radioactively contaminated material deposited at the Site has been characterized as containing radium, thorium, uranium and other radionuclides. However, the precise concentrations of radium, thorium, uranium and other radioactive elements is not well established. Further examination of the available data indicate that earlier assessments of the Site may have overestimated the average concentrations of Ra and Th by as much as 10 to 50 times. This can largely be attributed to the methods of calculating average concentrations and to overly conservative estimates of radionuclide ratios. Upon examination of available data, more precise assumptions than those previously applied have been identified which significantly affect the estimation of the radionuclide concentrations at the Site. However, the results from this investigation will allow a more accurate assessment of concentrations and ratios of Ra, Th, and other radionuclides at the Site. The results of this investigation will provide for assessment of the actual conditions at the Site.

Radionuclides identified as being present in concentrations in excess of background, based on sampling performed by RMC (Radiological Management Corporation, 1982) and sampling on adjoining property by Dames & Moore (Dames & Moore, 1990), are primarily uranium and uranium decay chain products; uranium-234 & 238, thorium-230, radium-226, and various radon daughters. Non-radioactive chemicals potentially present at the site were identified based on sampling performed primarily by BMD (Burns & McDonnell, 1986). The sampling data collected to-date have not indicated significant priority pollutant contamination in soil or groundwater, since the detection of these contaminants has been scattered and irregular, and, in some cases, suggestive of laboratory contamination. Non-radioactive organic chemicals that were detected in previous sampling include; methylene chloride, phenol, acetone, hexachlorobenzene, and bis (2-ethylhexyl) phthalate. Non-radioactive inorganic chemicals that were detected by past sampling include antimony, arsenic, cyanide, iron, lead, nickel, sodium, thallium, and zinc. Total petroleum hydrocarbons (TPH) and chlorinated pesticides were also identified as a potential concern.

While it appears that the primary chemicals of concern at the Site are radionuclides, non-radioactive priority pollutants and inorganic chemicals cannot be eliminated as being of potential concern based on the currently available data. The sampling performed to-date has failed to clearly indicate whether a number of specific chemicals within broad chemical classes; i.e., volatile organic compounds, semi-volatile organic compounds, organochlorine pesticides, priority pollutant metals and TPH are present at the site at levels above background, since in most cases background was not well established by the sampling. Potential chemicals of concern, which are those chemicals that have been specifically detected in previous sampling and/or identified by the EPA in the Administrative Order on Consent (AOC) for the site, as well as the broader classes of chemicals of concern are summarized in Table 4-1. The sampling identified in this work plan should aid in more clearly defining the specific chemicals of concern at the site.

4.3 Potential Migration Pathways

This section presents a discussion of the various media at the Site which may provide potential routes of contaminant migration. In general the contaminants at the Site may migrate via the following media:

- Air;
- Erosional sediment/Surface water;
- Leachate throughflow; and
- Groundwater.

The following is a discussion of the available information regarding each of these media.

4.3.1 Air

The occurrence of contaminants in the air has only been directly addressed by very limited sampling to-date. One series of measurements of airborne radioactivity was performed as discussed in Section 3 of this work plan. The occurrence of radioactive or priority pollutant contaminants in air may result from either volatilization, or the resuspension of the contaminants by physical disturbance such as wind, traffic, or earth moving. In addition, ionizing radiation produced by radioactive contaminants can travel through the air. Non-volatile contaminants are likely to be released to the air only if they are present on the surface or are brought to the surface by site disturbing activities where they are subject to resuspension mechanisms. In the case of volatile organics or gaseous contaminants, such as radon gas which is a product of the

Table 4-1 Potential Chemicals or Class of Chemicals of Concern radioactive decay of uranium-238, release may occur even when these contaminants are not present at the surface. However, the deeper in the soil that these volatile or gaseous contaminants are found the less likely their release will be to the air. Airborne contamination can be quantified through the modeling of release mechanisms that take into account the range of potential environmental conditions at the site based on the amount of contamination measured in the soil and other site-specific characteristics, or airborne contamination can be directly measured under conditions encountered at the time of sampling.

The operational and investigative history of the Site indicates that during operation of the Unregulated Landfill, the landfill materials were periodically covered with soil. The radioactive waste and soil mixture was placed on top of the existing landfill materials. Further, following initial investigation, additional soil cover has been added to the areas of the Site where this waste was identified. This soil cover will likely retard the volatilization of any of the contaminants. It will also attenuate any ionizing radiation passing through the soil. The potential for release of contaminants into the air by physical action is also reduced by the cover placed over the Site. The characterization of contaminant distribution in soil will support estimates of airborne contamination that, in the case of radon, will be confirmed with some direct air measurements.

4.3.2 Erosional Sediment/Surface Water

Surface water run-off is a potential avenue for overland transport of sediment and dissolved constituents. Surface water run-off locally ponds after a rainfall and may be a source of groundwater recharge also. Runoff from Area 1 flows to the north towards St. Charles Rock Road; surface water runoff is also to the south and toward the former quarry pit. Runoff from Area 2 is primarily to the north toward the Ford property; a portion of the flow is also toward the former quarry pit.

Contaminated soil may be brought to the surface and transported via surface water run-off as a result of erosion and sloughing of the landfill cover, particularly along landfill slopes. Erosional sediment transport was the likely mechanism of transport of radioactive contamination to areas adjacent to the Site detected in the sampling performed by Dames and Moore (1990 & 1991). Cultivation of the adjacent lands can lead to the further redistribution of contaminated erosional sediment. Contaminated erosional sediment may also be carried by, or contaminants may be dissolved in, surface water runoff that enters nearby surface waters. The characterization of contaminant transport via erosional sediment will require the evaluation of contamination in surface soil and surface waters adjacent to the Site for the non-volatile materials of concern.

4.3.3 Leachate and Leachate Throughflow

Leachate is water that has percolated through the unsaturated soil and landfill materials that may contain either dissolved or entrained contaminants. Leachate is typically an intermediate transport matrix that eventually migrates to and enters groundwater. The potential for direct exposure to contaminants in the leachate is usually rather limited. It may be possible, under certain circumstances, for leachate to escape the landfill, via seeps in landfill cover soils. This leachate throughflow could result in mass-wasting (sliding and slumping) of the slope face. Leachate seeps along the north slope face, near the toe were identified by USEPA, MDNR, and NRC during their February 3, 1992, visit. Typically samples of leachate are collected in engineered or natural sumps that collect leachate from an area of the landfill. No engineered or natural sumps are known to exist at the Site. Leachate will be sampled from seeps through the berm if sufficient volume is available.

4.3.4 Groundwater

There are two potential shallow aquifers at the Site; the Missouri River alluvium and the shallow limestone bedrock. Below the shallow limestone is the relatively impermeable Warsaw shale. Based on the evaluation of available data, both of these water-bearing units are under unconfined aquifer conditions. Hydrogeologically, Areas 1 and 2 are situated on the flood plain of the Missouri River. Groundwater is encountered within the alluvium at a depth of approximately 10 feet or less below natural ground surface, and fluctuates seasonally. Groundwater generally occurs below the depth of the landfill debris in both of these areas; however, during the 1993 floods, groundwater saturated the lower portion of the debris in Area 1. (Groundwater elevation data collected on August 5, 1993, are included in Appendix D.)

The overall groundwater flow direction beneath the Site is to the northwest. The alluvium has a high hydraulic conductivity, especially in the lower portion of the aquifer where sands and gravels predominate, and is fully saturated from the top of groundwater surface (approximately 10 feet below natural ground surface) to the top of the underlying limestone. Limited groundwater is present in the limestone bedrock, and where present is generally restricted to open fractures and along bedding planes. The hydraulic conductivity of the limestone is expected to be several orders of magnitude lower than the alluvium. The source of water to the limestone bedrock is primarily from the overlying alluvium.

Groundwater flow direction is complicated by the presence of surface water ponds and collection basins along the eastern and western property boundaries, and a former limestone quarry which is situated south of Areas 1 and 2 in the southern portion of the Site. The abandoned quarry is currently used as a regulated landfill and includes dewatering wells for leachate control. The limestone surrounding the former quarry was pressure grouted, and the interior walls of the quarry were sealed with a clay liner prior to use as a regulated landfill.

Review of groundwater contour maps shows that a groundwater trough is present within the central portion of the property. This trough is oriented in a northwesterly direction. Groundwater flow is directed towards the center of the property and exits on the north, beneath Area 2. It is believed that the groundwater trough is the result of surface water infiltration and groundwater recharge from the perimeter ponds and collection basins, and the effects of the former limestone quarry which acts as an upgradient obstruction to groundwater flow (see Section 3.3.2.1 for further explanation). The Sampling and Analysis Plan has been developed to test this hypothesis. Surface water infiltration along the eastern and western perimeter of the property may effectively control contaminant migration in these directions.

Soluble contaminants may enter groundwater as a result of surface water infiltration and leachate flowing through the waste materials, or direct groundwater contact with contaminated fill materials.

4.4 Potential Receptors

A key factor in determining the risks associated with contaminants present at the Site involves the identification of potentially exposed populations (human and ecological) both on-site and in the surrounding areas. The locations of residents, workers, and wildlife populations relative to the Site and the nature of nearby land use must be characterized in order to determine if individuals or populations are likely to be exposed to contaminants released from the Site through one or more migration pathways.

For exposures to occur there must exist a complete exposure pathway. Each of the following elements must be present for such exposures to occur:

- A contaminant release;
- An environmental transport medium (e.g., water, soil);
- Individual contact with the medium; and
- A route of intake/exposure (e.g., inhalation, ingestion, direct radiation exposure, dermal contact).

Selection of receptors for evaluation will be performed based upon contaminant migration pathways identified during the Site investigation. Priority screening of potential pathways and likely receptors will be completed as part of the preliminary risk assessment. The Site investigation will characterize contaminant occurrence, and support the identification and evaluation of environmental exposure pathways. For on-site receptors, a reasonable, future land-use scenario must be established in order to fully evaluate potential receptors and the impact to these receptors from known contaminants at the Site.

Initially, the potential receptors of concern at the site can be grouped into the following categories:

- The general public
- On-site workers
- Ecological

Each of this groups is discussed briefly in the following sections.

4.4.1 General Public

Areas in the vicinity of the Site are primarily industrial/commercial with the nearest residential areas lying approximately one mile away. Exposures of the general public, including nearby workers, to contaminants from the site would be associated with either the intrusion of individuals onto the site, or the transport of site derived soils, surface water, or groundwater to off-site locations.

The West Lake Property is currently fenced, therefore, for current-day uses, public contact with contaminants on-site would be limited to intruder scenarios. Individuals intruding onto the site would come into contact with contaminants in much the same ways as on-site workers, but in most cases to a much more limited extent.

As described earlier, studies have indicated that erosion of the soil by wind or water may have been responsible for some limited migration of contaminants from the Site to adjoining fields. These contaminated erosional sediments and any associated contaminated surface water run-off could be a source of public exposure.

A potential concern with regard to the definition of exposure of the general public is characterization of the potential for contaminant migration to the Missouri River which is used for potable water. Surface run-off from the Site enters the Missouri River just upstream of river mile 28. The water supplies for the City of St. Charles are drawn from the opposite (north) bank of the river at mile 29, which is upstream of where run-off from the Site enters the River and therefore should not be impacted by surface run-off from the Site. The St. Louis Water Company North County Plant is at mile 20.5, approximately 7.5 miles downstream of where run-off from the Site enters the River. The Site is a considerable distance from the identified surface water withdrawal points and would be unlikely to have a significant impact on these distant waters, however, the potential for any impact needs to be examined.

Users of groundwater in the vicinity are of potential concern. Groundwater in the area is not used for municipal purposes, but some private wells used for domestic purposes and irrigation have been identified in the area. According to the "Preliminary Health Assessment for the West Lake Landfill" (1990), four wells in the vicinity of the West Lake Property have been monitored by the Missouri Department of Health during recent years and have shown no contamination above USEPA's gross alpha activity standard for drinking water. These wells were also analyzed for a number of pesticides and were below detectable limits. The potential for contaminants to migrate to these wells will be further evaluated during the Site Investigation.

The exposure of workers at facilities adjacent to the site, such as the Ralston-Purina Plant and Hussman Refrigeration located to the east, across St. Charles Rock Road may also need to be considered if airborne contaminants are identified as a significant concern.

4.4.2 On-Site Workers

On-site workers, including individuals involved in ongoing landfill operations, the asphalt and cement plants, as well as, workers that might become involved in any remedial actions or other site-disturbing activities at the site are potential receptors of interest. To the extent that any surface soil contamination exists on-site, or site disturbing activities are undertaken that bring contaminants to the surface, workers may come in direct contact with contaminants in soil. Surface contamination can also be the source of airborne contamination, as can gaseous or volatile subsurface contamination. In the case of radioactive contamination, penetrating radiation can also be a concern for on-site workers.

4.4.3 Ecological

The majority of on-site areas represent relatively disturbed habitats as a result of the landfill operations. However, the presence or absence of critical habitat at the Site for any threatened or endangered species will be established as part of the investigation. Since site contamination has been covered with fill, terrestrial species' contact with contamination from the site would be limited to burrowing species, unless a slope failure occurs that produces a loss of soil cover. If a slope failure occurs, then this may result in exposure of potentially hazardous underlying materials. Exposure to other ecological receptors, as well as on-site workers and the general public could then occur through direct contact and airborne releases.

With regard to impact on potential aquatic populations, the magnitude and extent of any surface water contamination has not been well characterized at the site. As a result, such a characterization would be necessary to assess any potential impacts to aquatic populations present in surface water features near the site.

4.5 Conceptual Model

The conceptual site model is based on site specific conditions, the contaminants of concern, and the potential for these contaminants to migrate off-site and impact receptors, both human and environmental. Each of these elements of the conceptual model have been described in the preceding sections. Key elements of the model, contaminant transport potential and receptor exposure routes, which will serve as the basis for designing the site investigations that will support further site evaluation and the testing and refinement of the conceptual model itself are summarized in Tables 4-2 and 4-3.

Table 4-2 summarizes the qualitative evaluation of migration/transport potential of the various classes of contaminants of concern at the site. The radioactive metals, primarily uranium, thorium, and radium, and the metals in general are relatively immobile under normal pH conditions and significantly less mobile under the high pH (basic) conditions that are likely prevail at the site as a result of the presence of limestone. However, uranium in the presence of carbonates, such as limestone, can form soluble carbonate complexes that increase its mobility in groundwater. Volatile organics can be quite soluble in water, and are readily transported in groundwater. However, due to the typically high vapor pressure of these organics, they rarely remain to any significant extent in surface waters, and as a result, surface water transport is of limited concern. Semi-volatiles typically have low to moderate solubilities in water, therefore water has a moderate potential to transport these materials. Chlorinated pesticides typically have low water solubilities and bind strongly to soils giving them limited transport potential in groundwater or surface water.

Soil is expected to have a relatively limited role in transporting contaminants from the Site to receptors. The majority of the contamination is likely to be found in soils that lie beneath the landfill cover soils, effectively limiting the extent to which contaminated soils are likely to reach receptors without significant site disturbance. An exception is the slope of the landfill; slope failures can occur and can lead to exposure of potential underlying contaminants and mass transport of those materials. A slope failure had occurred on the north face of the landfill and erosional transport has locally lead to the migration of radionuclides onto the adjacent Ford property. The slope of the landfill has been mitigated with the placement of additional soil cover. The soil that has migrated onto the Ford property may have resulted in the presence of contaminants near the ground surface. Exposure to possible contaminants in this area can potentially occur through direct contact or airborne releases.

The air is an effective media for transporting the gaseous radon daughters and volatile organics. However, airborne transport of the contaminants with low volatility is likely to be of limited importance since it would require the resuspension of surface contamination that would be subject to redeposition.

Table 4-3 summarizes the principal media of concern from the standpoint of potential contaminant exposure for each of the identified receptor groups. Site investigations are designed support further site evaluation and the testing and refinement of the conceptual model itself are summarized in Tables 4-2 and 4-3.

Table 4-2 summarizes the qualitative evaluation of migration/transport potential of the various classes of contaminants of concern at the site. The radioactive metals, primarily uranium, thorium, and radium, and the metals in general are relatively immobile under normal pH conditions and significantly less mobile under the high pH (basic) conditions that are likely prevail at the site as a result of the presence of limestone. However, uranium in the presence of carbonates, such as limestone, can form soluble carbonate complexes that increase its mobility in groundwater. Volatile organics can be quite soluble in water, and are readily transported in groundwater. However, due to the typically high vapor pressure of these organics, they rarely remain to any significant extent in surface waters, and as a result, surface water transport is of limited concern. Semi-volatiles typically have low to moderate solubilities in water, therefore water has a moderate potential to transport these materials. Chlorinated pesticides typically have low water solubilities and bind strongly to soils giving them limited transport potential in groundwater or surface water.

Soil is expected to have a relatively limited role in transporting contaminants from the Site to receptors. The majority of the contamination is likely to be found in soils that lie beneath the landfill cover soils, effectively limiting the extent to which contaminated soils are likely to reach receptors without significant site disturbance. An exception is the slope of the landfill; slope failures can occur and can lead to exposure of potential underlying contaminants and mass transport of those materials. A slope failure had occurred on the north face of the landfill and erosional transport has locally lead to the migration of radionuclides onto the adjacent Ford property. The slope of the landfill has been mitigated with the placement of additional soil cover. The soil that has migrated onto the Ford property may have resulted in the presence of contaminants near the ground surface. Exposure to possible contaminants in this area can potentially occur through direct contact or airborne releases.

The air is an effective media for transporting the gaseous radon daughters and volatile organics. However, airborne transport of the contaminants with low volatility is likely to be of limited importance since it would require the resuspension of surface contamination that would be subject to redeposition.

Table 4-3 summarizes the principal media of concern from the standpoint of potential contaminant exposure for each of the identified receptor groups. Site investigations are designed

Table 4-2 Contaminant Transport/Migration Potential

Table 4-3 Potential Contaminant Exposure Routes to be Addressed to address the question of the extent to which the general public may be exposed to Site derived contaminants present in groundwater, surface water, and soils/sediments. On-site workers are most likely to encounter contaminants in site soils/sediments and in the air. While for wildlife populations, the extent of exposure to contaminants in surface waters needs to be characterized.

5.0 WORK PLAN RATIONALE

The overall objective of the Work Plan is to define those activities necessary to investigate areas of the Site that may pose a threat to human health and the environment. In accordance with the AOC and SOW, the investigation will examine the physiography, geology and hydrology of the Site, will determine the nature and extent of contamination in Radiological Areas 1 and 2, and will determine the impact of this contamination on potentially affected media.

5.1 RI/FS Data Objectives

The following data objectives have been established based upon the data needs identified as part of our review of existing information and development of the conceptual model:

1. Determine the horizontal and vertical extent and magnitude of on-site radiological and nonradiological contamination and off-site radiological contamination related to Areas 1 and 2 in the alluvial and bedrock aquifers, alluvial soil, surface water and sediments.

2. Determine the nature and extent of radiological contaminants in air.

3. Based upon the radiological data collected determine the ingrowth of decay products.

4. Identify contaminant migration pathways and barriers.

5. Evaluate and determine the hydrogeologic characteristics of the alluvial aquifers (including groundwater head distribution, seasonal conditions and groundwater conductivity parameters).

6. Describe on-site and off-site features (including utilities) that could affect implementation of remedial measures.

7. Describe background soil and groundwater quality.

8. Develop a conceptual model of groundwater/hydrostratigraphic relationships.

9. Determine contaminant and groundwater boundary conditions.

10. Characterize the soils beneath and adjacent to the landfill for geotechnical and hydrogeological properties that could affect selection of a remedial alternative (including stability of the northern berm face).

11. Describe the relationship between groundwater and surface water flow.

12. Determine nature of ecosystems at the Site (presence of habitat for threatened and endangered species).

13. Collect sufficient information to support human health and ecological risk assessment.

5.2 Work Plan Approach

Evaluation of the data from the preliminary investigations provided valuable data, however, additional information is required for a complete and thorough assessment of the risks to human health and the environment posed by the contaminants at the Site. Additional information is also required for the proper assessment of the feasibility of various remedial actions at the Site. Additional soil, groundwater, and air investigations will be conducted at and in the vicinity of the Site to more adequately evaluate the environmental conditions.

5.2.1 Remedial Investigation Activities

The following subsections describe, in general, the remedial investigation activities that will be conducted at the Site to provide the information required to complete the RI/FS in accordance with the AOC and SOW. These activities include: site inspection and radiological survey; site physical and biological characterization; site hydrogeologic and chemical characterization; and airborne radiological contamination. Detailed descriptions of the planned remedial investigation activities are presented in Section 6.0.

5.2.1.1 Site Inspection and Radiological Survey

As specified in the SOW, initial Site investigation activities will be conducted to determine the risks of exposure at the Site to radioactive emissions in surface soils and sediments. During this time, strict control on access to the Site will be followed. A direct measurement of gamma levels will be performed on a grid pattern throughout and surrounding Radiological Areas 1 and 2, and include a portion of the adjacent Ford property. The measurement grid will extend out of the previously designated Site boundaries, and include examination of the slopes (berm) along Radiological Area 2. The gamma survey will provide a preliminary indication of the extent of radioactive contamination at the Site and will assist in determining appropriate access restrictions to Areas 1 and 2.

Leachate sampling will be conducted from seeps on the north side of the berm in Area 2, and any other areas where seeps are observed. If the quantity of water is not sufficient for sampling and analysis, then saturated soil samples will be collected analyzed.

Sampling of the surface water body north of Area 2 will be performed. Staff gages will be placed in surface water bodies to determine the relationship with shallow ground water beneath the site. These gages will be checked monthly in conjunction with groundwater elevation monitoring.

The Site will be carefully, visually inspected to identify pathways of surface water run-off and areas of potential erosion on and around the Site. Samples will be collected of erosional sediments and rainwater run-off to determine if contaminants are migrating from the Site by overload flow and erosion. A visual inspection of the slopes that bound Areas 1 and 2 will be conducted to evaluate evidence of slope instability.

5.2.1.2 Site Physical and Biological Characteristics

The physical, ecological, and demographic conditions on and around the Site will be re-examined. While a considerable amount of such information has been previously collected, re-examination is needed to confirm the previous findings, determine if conditions have changed significantly, and supplement the information collected.

While the regional geology is generally well characterized, an examination of local surface expressions will be made to determine the presence of any particular characteristics that may be significant to the activities at the Site. The physical condition of the Site will be examined and documented. This will include topography, current on-going on-site activities, location of structures and features, and examination of ground cover, surface water, flora, and fauna.

The local residential and commercial characteristics, as well as population growth and decline will be examined. The density and location of residences surrounding the Site will be characterized. The occurrence of private water supply wells reported from previous studies will be examined. The density and location of commercial activities surrounding the Site also will be characterized.

5.2.1.3 Site Geological and Chemical Characteristics

One of the objectives of the remedial investigation is to better define the geological and chemical characteristics at the Site. To accomplish this objective, the characteristics of the soil at the Site, the groundwater in the immediate vicinity of the Site, and the various fill materials at the Site will be examined.

Soil borings will be drilled within and immediately around the perimeter of Areas 1 and 2. Soil borings will be located at radiological "hot spots", as determined by the planned overland gamma survey, and at other biased locations as identified from review of historical aerial photographs by McLaren/Hart and data from previous investigations. Soil borings will also be placed at locations within Areas 1 and 2 using a stratified random selection scheme to evaluate the overall character of these landfill deposits. In the event that no "hot spots" are identified, additional sample locations will be selected using the stratified random selection scheme.

Prior to the drilling of the soil borings a landfill gas survey will be performed. This survey will involve the collection of landfill gas samples using a probe (methane analysis only) at each of the planned boring/well locations. Landfill gas samples will also be collected at eight locations using a flux chamber placed on the ground surface. These additional samples will be analyzed for volatile contaminants of concern. The eight locations correspond to planned random surface soil sample locations.

Soil samples will be collected from borings and will be analyzed to provide information on the contaminants of concern. Site-specific geologic characteristics will be determined during soil borings. Soil cores and/or cuttings will be classified according to the Unified Soil Classification System. Soil cores and/or cuttings will also be characterized as to color (utilizing Munsell soil color charts), moisture content, odor (if present), and other distinguishing physical characteristics. The physical characteristics and depth of refuse materials will also be identified from the soil borings. Soil boring logs will be prepared in the field, then drafted for inclusion in the RI/FS report. Soil samples from each boring will be analyzed for the contaminants of concern. Down-hole radiation surveys will be performed in the soil borings to provide information regarding vertical and horizontal distribution of radiological contamination. If perched water is encountered during the drilling of the soil borings, then efforts will be made to collect a sample using a hydropunch for laboratory analyses.

Soil borings drilled at the perimeter of Areas 1 and 2 will be completed as monitoring wells. These perimeter borings/wells will be biased sampling locations, and located based on our current understanding of groundwater flow conditions beneath the Site. The planned perimeter monitoring wells will be completed as shallow, intermediate depth, and deep alluvial wells. During drilling of the monitoring wells, soil sampling within the saturated zone will be performed for lithologic purposes only; no chemical analyses are planned at this time. The need to retain selected soil samples for laboratory analyses will be reconsidered during drilling activities, and will be based on visual evaluation and field monitoring of the soil samples.

Groundwater samples will be collected from monitoring wells at the Site. Site-specific hydraulic characteristics will be determined by performing slug tests on newly constructed monitoring wells at the Site. Flow direction and gradient will be determined by measuring water levels within existing and newly constructed monitoring wells at the Site.

As stated in Section 5.2.1.1, rainwater run-off and sediment will be collected and analyzed at locations where surface discharge from Areas 1 and 2 occurs. Sampling of surface water from the surface body north of Area 2 is planned, along with leachate sampling from seeps which may be identified.

5.2.1.4 Air Monitoring

Three potential air contaminant concerns have been identified at the site. The first concern arises from the generation of radon from radioactive decay of waste, the second is the potential presence of landfill gas and other non-radiological volatile chemicals of concern, and the third is fugitive dust.

Radon flux measurements will be taken in both Areas 1 and 2 of the site. Flux measurements will be taken at identified radioactive "hot spots" and at other locations that are randomly selected. Samples will be collected using commercially available, charcoal-based radon canisters suspended in an inverted container such as a plastic bowl or bucket. Each canister/container assembly will be left in place for 2 days to determine average radon flux levels at the Site. Two rounds of sampling will be conducted, with the intent of having the sampling rounds separated by a significant amount of time so that radon flux under two different sets of meteorologic conditions can be established.

The second issue related to airborne contamination is the potential for the presence of landfill gas. Migrating landfill gas can potentially contaminate groundwater or be released to the air. As part of efforts to characterize the nature and extent of non-radioactive contamination in Areas 1 and 2, a landfill gas sample will be collected at each planned boring and well location using a probe (methane analyses only). Eight additional air samples will be collected from the surface of the landfill using a flux chamber. These additional samples will be analyzed for volatile organic chemicals of concern.

The third airborne concern is entrainment of contaminants in fugitive dust. Sampling of fugitive dust from non-vegetated areas and roadways will be performed in conjunction with the landfill gas sampling program.

5.3 Preliminary Identification of Remedial Response Objectives

Preliminary remedial response objectives have been developed during the scoping of the RI/FS to assist in identifying potential remedial technologies and response actions, which can be utilized to develop preliminary remedial alternatives. The remedial action objectives are based on the background information, provided by previous investigations, and the conceptual Site model. Overall, the objective of remedial action is to ensure the protection of human health and the environment.

Table 5-1 is a preliminary identification of remedial action objectives for media of potential concern at the Site. The nature and extent of contamination of these media as well as the potential for exposure will be defined by the RI.

Data collected during the RI, along with the results of the Baseline Risk Assessment to be conducted by USEPA will be combined with Applicable or Relevant and Appropriate Requirements ("ARARs") to revise the remedial action objectives, as necessary.

Table 5-1 Preliminary Remedial Action Objectives

5.3.1 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) have been developed to establish initial targets to use in the analysis of remedial alternatives and to more clearly define remedial investigation data needs. The PRGs identified here are based on chemical-specific potential ARARs or risk-based calculations. The risk-based PRGs are developed using a default 10^{-6} risk target and default exposure assumptions that will over-state actual exposures and may lead to lower than necessary (from the standpoint of health risk) remediation targets. These remediation goals should be revised at the end of the RI or during the FS to more accurately reflect site-specific conditions and potential health risks using information gained as a result of further site investigation.

Based on the conceptual model for the site, contamination has been identified as being present, or potentially present in groundwater, surface waters (from run-off or erosional sediment), soils, and the air (Table 5-1). Section 4.2 identified the potential chemicals of concern at the site.

Land uses at and in the vicinity of the site are commercial/industrial with the nearest residential areas lying approximately one mile from the site. Based on current land use of the site and neighboring properties, the most-probable future land use is commercial/industrial. It is noted that a portion of Area 2 is currently zoned residential; however, a prior judicial determination (Westlake Quarry and Material Company vs. City of Bridgeton, Case 761 S.W.2D 749,753 [MoAP 1988]) directed at the property directly south of the Westlake Landfill (toward the referenced residential area) found that the residential zoning was unconstitutional, unreasonable, and arbitrary. The court held that "[t]he evidence regarding the adaptability of the property for development under its current [residential] zoning showed that residential development, although theoretically possible, is not economically feasible." In evaluating a reasonable maximum exposure scenario, the Preamble to the 1990 NCP states that "... only potential exposures that are likely to occur will be included in the assessment of exposures.

PRGs for the chemicals of concern are developed based on the following typical exposure pathways:

Water (Ground & Surface)	• Ingestion from drinking • Inhalation of volatiles
Soil	• Ingestion • Inhalation of volatiles/gases

- Direct external exposure (radionuclides)

While the ingestion of groundwater or surface water is unlikely based on the commercial/industrial setting, it is believed that the groundwater is potentially suitable for drinking, and surface waters are potentially in communication with distant waters that are drinking water sources. Therefore, the initial PRGs reflect the broad NCP goals of assessing waters based on their highest beneficial use by treating them as potential drinking water. This assumed water use will need to be reevaluated during the RI/FS process. It should also be noted that these PRGs take into consideration exposures to contaminants via the air pathway. Exposure to daughter products from the radionuclides, including the production of radon-222 from radium-226 is also considered.

Risk-based PRGs calculated using default (conservative) exposure assumptions are summarized in Table 5-2. It should be recognized that the PRGs presented in Table 5-2 in many cases represent concentrations that are significantly below natural background, since they are based on a 10^{-6} health risk level that in many cases is exceeded at normal background concentrations. These initial PRGs will require revision during the RI/FS process to more accurately reflect background conditions.

5.3.2 Data Quality Needs

Data quality needs are established by defining data uses, appropriate analytic levels, contaminants of concern, critical samples, level of concern, and required detection limits. Each of these elements are addressed in this section.

One of the first steps in defining data quality needs is the identification of data uses for each of the planned contaminant investigation activities. Table 5-3 summarizes the principal data uses for each of the work plan activities. In addition the table indicates the appropriate analytic levels and critical samples associated with the activities. Analytic levels are defined in the guidance manual Data Quality Objectives For Remedial Response Activities Development Process (EPA, March 1987). In this guidance five (5) levels of data quality are defined as follows:

Level I: A Level I DQO applies to all field screening methods using portable equipment. The results are collected in real time and are not compound-specific. The data generated by these methods does not undergo QA/QC procedures.

Table 5-2 Initial PRGs for Chemicals of Concern

Table 5-2 continued

Table 5-2 continued

Table 5-3 Data Quality Needs

Level II: A Level II DQO is applicable to data obtained from the use of portable field equipment that is set up in a portable laboratory or is similar to laboratory equipment (e.g., a field GC or field GC/MS). The operation of these instruments depends on the proper use of suitable calibration standards, reference materials and sample preparation. Results of measurements with this type of equipment are real time or within a few hours. The data generated by this method do not undergo QA/QC procedures.

Level III: A Level III DQO is applicable to data obtained from the analysis of samples in off-site laboratories. These analyses may or may not use EPA Contract Laboratory Program (CLP) methodology and do not require QA/QC validation or data packages. The laboratory does not need to be CLP certified.

Level IV: A Level IV DQO applies to data obtained from analysis of samples in an off-site CLP certified laboratory using CLP protocols and subject to rigorous QA/QC protocols and documentation.

Level V: A Level V DQO applies to data that are analyzed in an off-site laboratory using methods that are developed or modified to meet specific requirements, constraints or detection limits. The laboratory used for these analyses may or may not be CLP certified.

Critical samples are those for which valid data must be obtained to satisfy the objectives of the sampling and analysis task. Critical samples represent data points that are considered vital to the decision making process.

Levels of concern specify a concentration above which some action may need to be taken. At this point in time in the investigation process, the preliminary remediation goals (PRGs) are used as levels of concern and are summarized in Table 5-4. As indicated earlier, the PRGs may be overly conservative since they are based on a conservative calculation of a 10^{-6} health risk level that in some cases exceeds background concentrations. Therefore, Table 5-4 also includes some typical background levels (Missouri) reported in the scientific literature for perspective. The reporting limits for the analyses to be performed are also identified in Table 5-4 and were developed considering the PRGs and their conservatism, background levels likely to be encountered at the site, and the application of commonly used analytic techniques.

Table 5-4 Data Quality Objectives

Table 5-4 continued

6.0 REMEDIAL INVESTIGATION TASKS

This section describes the activities that will be conducted during the planned remedial investigation. The objectives of this investigation and specific activities to be performed are summarized in Table 6-1. Details and procedures for performing the planned field activities are provided in the Sampling and Analysis Plan, included as Appendix A to this RI/FS Work Plan. A Site Safety and Health Plan has been prepared as part of the development of this work plan and is presented under separate cover.

The planned investigation is designed to be completed in one field mobilization, if possible. Contingencies are included as part of the investigation to address possible anticipated conditions that may trigger the need for additional sample collection and analysis, or for the construction of additional on-site monitoring wells. If data suggest that radionuclides may be present in soil or groundwater off-site at levels that exceed the established background levels, then a recommendation will be prepared and submitted to the USEPA regarding the need for a second phase of investigation.

Evaluation and establishment of background conditions is a concern on all sites and is particularly difficult for this site. Soils that are of interest to the investigation include the alluvium that underlies the landfill, and the soils that are interlayered within the landfill debris. These latter soils may include soils that were disposed in the landfill, and also those that were used as landfill cover. Soil cover materials may have been obtained on-site or near the Site, and therefore be similar to the alluvium; or they may have been obtained from numerous off-site locations and be totally dissimilar to the alluvium.

In order to establish a representative site-specific soil background measurement, an attempt will be made to identify an off-site, background reference sampling location that has surface soils that are similar to the majority of the alluvium found on the Site. Additionally, if sources of the soil cover in the landfill can be clearly established such as any borrow areas on or near the Site, or specific uncontaminated areas of the Latty Avenue site can be identified, then these sites may be proposed by the Respondents as additional background reference sampling sites for USEPA approval. Landfill areas outside of Areas 1 and 2 that have not been radiologically impacted may also be considered for background reference evaluation (e.g., the planned perimeter monitoring well soil borings).

Table 6-1 Remedial Investigation Objectives

Table 6-1 continued

Table 6-1 continued

Background groundwater quality is equally difficult to evaluate and establish for this Site. Issues that will impact determination of background conditions include the following:

- The historic edge of the Missouri River alluvial valley is located within the southern portion of Area 1. Sediments north of this contact are underlain by river alluvium; sediments south of this contact are underlain by loess and shallow limestone bedrock. Water quality data from a well placed upgradient, and off-site (south of the Site) will be representative of background conditions in the loess and limestone, and not the alluvium that underlies Areas 1 and 2.

- A treatment retention pond is located southwest and south of Areas 1 and 2, respectively. Smaller surface water bodies are also located north and east of this retention pond. Water elevation data for monitoring wells in the vicinity of the pond and smaller surface water bodies suggest that leakage from one or more of these surface water features may be occurring and act as a source(s) of groundwater recharge. If groundwater recharge is occurring, then water quality data from a well located downgradient of these features may not be representative of background conditions. A well placed upgradient of these areas will be representative of the loess and limestone, and not the alluvium.

- Groundwater flow beneath the Site is believed to be impacted by the former quarry that is located upgradient of Areas 1 and 2 and acting as a groundwater obstruction. The surface water bodies that bound the West Lake property on the east and west may be sources of groundwater mounding and recharge. If the perimeter surface water bodies are contributing to groundwater, then water quality data from the existing and planned monitoring wells along the perimeter of Areas 1 and 2 may not be representative of background conditions.

- One alluvial aquifer exists beneath site. Groundwater recharge occurs from the loess and shallow limestone south of the Site, and also from surface water infiltration. It is not known whether vertical differences in water quality in the alluvium naturally exist and reflect the various sources of groundwater recharge.

As a result of the above concerns, there is insufficient data at this time to determine whether water quality data from one well will be indicative of background conditions. Statistical analysis of data from several wells may be a reasonable method to determine background conditions.

Confirmation of groundwater flow direction will be critical for selecting the wells that could be included in a statistical analysis.

Background sampling and analysis are only briefly discussed further in this work plan. Additional data collected as part of the remedial investigation will provide further in-sight into how background soil and groundwater conditions are to be established. The respondents will present to the USEPA a plan for establishing background conditions after all of the planned soil borings have been drilled and the first round of sampling for the newly constructed and selected existing wells has been completed.

Radionuclides, metals, and chemical compounds have been detected during previous investigations. The chemicals of concern for the remedial investigation include four primary radionuclides (Uranium-235 and 238, thorium-230, and radium-226) and analytes that may be found in the following laboratory analytical methods: volatile organic compounds (VOCs) by EPA Method 8240; semi-volatile organic compounds (SVOCs) by EPA Method 8270; total petroleum hydrocarbons (TPH) by EPA Method 8015M; pesticides and PCBs by EPA Method 8080; priority pollutant metals by EPA method 6010/7000; and cyanide by EPA Method 9010.

Pursuant to the USEPA request in a letter dated February 18, 1994, selected samples will be analyzed for thorium-232.

The planned field activities include the following tasks. Each of these tasks are described below:

- Field Surveillance
- Overland Gamma Radiological Survey
- Soil Borings and Sample Analyses
- Groundwater Monitoring Well Construction, Elevation Monitoring, and Sampling
- Surface Soil Cover Sampling and Analyses
- Leachate Sampling and Analyses
- Rainwater Run-Off and Erosional Sediment Sampling and Analyses
- Surface Water Sampling and Analyses
- Geotechnical Evaluation of Area 2 Landfill Slopes (Berms)
- Radon Sampling and Analysis
- Landfill Gas Sampling and Analysis

Air monitoring will be performed during several of the above tasks for health and safety purposes. Air monitoring for potential fugitive dust transport, and evaluation of potential volatile chemical release at the landfill surface will be performed as part of the planned landfill gas sampling and analysis task.

6.1 Field Surveillance

Immediately after mobilization to the field a reconnaissance survey of Areas 1 and 2, and adjacent areas will be performed. The purpose of this reconnaissance survey is to identify site features which may have changed since preparation of the work plan, and to identify site conditions which may affect the investigation and the development of remedial alternatives. Specific activities to be performed as part of the field surveillance include the following:

- Identify any changed site conditions which may impact implementation of the work plan.

- Verify locations for placement of staff gages and water quality sampling of the surface water body located north of Area 2. Areas of ponded surface water which may be present around the perimeter of Areas 1 and 2 will be noted, and considered for potential placement of staff gages and sampling.

- Verify rainwater run-off patterns and discharge locations, and identify areas of erosional sediment accumulation. Erosional sediments have flowed onto the adjacent Ford property; these deposits along with any other identified areas where erosional sediments may have flowed onto the adjacent properties will be mapped. Interim measures, such as placement of fencing around any identified areas to limit public access, will be proposed to the USEPA after the areas are identified, mapped, and more clearly delineated based on the planned overland gamma survey.

- Re-inspect soil cover in Areas 1 and 2, including the adjacent slopes (berms), for evidence of potential hazardous chemical accumulation. Designate any identified locations for surface soil sampling.

- Evaluate site for habitat of threatened or endangered species.

- Identify changes in residential and commercial development which may have occurred or may be in the developmental stages (i.e., locations of potential receptors) and verify locations of nearest private wells.

- Evaluate condition of all existing groundwater monitoring wells on the West Lake property and determine whether they may be suitable for groundwater elevation monitoring and potentially for water quality sampling.

Findings and observations from the field reconnaissance will be documented in a letter and forwarded to the USEPA.

6.2 Overland Gamma Radiological Survey

An overland gamma radiological survey will be performed to delineate Areas 1 and 2. The survey will also identify locations ("hot spots") for subsequent soil sampling and analysis. The over land survey will be performed on a 30-foot by 30-foot grid. This grid will extend beyond the currently defined limits of Areas 1 and 2, and will include the adjacent perimeter landfill slopes. Delineation of the "hot spots" may require a tightening of the grid, and this will be performed as required. Figure 6-1 identifies Areas 1 and 2 and the tentative radiological survey grids.

Radiological "hot spots" are defined as areas exhibiting gamma-ray exposure rates that are a factor of two higher than the exposure rates encountered in radiologically uncontaminated areas with otherwise similar soil characteristics. Background exposure rates are the basis of comparison for defining hot spots and are expected to fall in the range of 6 to 10 uR/hr. The average background radiation exposure rate reported by the National Council for Radiation Protection for middle America is 7 uR/hr (NCRP, Report No. 94, 1987). Local background will be established by taking a measurement off-site on the open field east of the site and east of the St. Charles Rock Road entrance to the site.

It is recognized that, as a landfill, the site likely has received soils from a variety of sources and, as a result, definition of a representative background sampling location is difficult. In order to establish a representative site-specific reference background measurement, an attempt will be made to identify an off-site, background reference sampling location that has surface soils that are similar to the majority of the soils found on the Site. If sources of the soil fill can be clearly established such as any borrow areas on-site or specific uncontaminated areas of the Latty

Figure 6-1 Map Showing Locations of Planned Overland Radiological Survey

Avenue site, these sites may be proposed by the Respondents as additional reference background sampling sites for USEPA approval.

In evaluating site measurements against background measurements and identifying "hot spots", consideration will be given to any apparent differences in soil type at the various on-site measurement locations, and the typical range of gamma-ray exposure rate values reported for regional soils. With the preceding caveat in mind, those locations indicated in the overland radiological survey as having maximum exposure rates greater than twice background, will be designated as "hot spots". In the event that there are; an excessive number of "hot spots" identified under this criteria, or the indicated locations are not sufficiently distributed across the Site, or no "hot spots" are identified, then recommended alternate locations for borings will be submitted by the Respondent Group to USEPA for review and approval.

The overland gamma survey will be performed using a hand-held, portable sodium-iodide, thallium-activated (NaI [Tl]) gamma-ray survey instrument to determine radiation levels in units of counts per minute (cpm). This instrument is ideally suited for rapid measurement of low level environmental radiation; providing nearly instantaneous measurement results.

The NaI detector will be cross-calibrated with an integrating, pressurized ionization chamber (ion chamber) at least once a day within the area to be surveyed. This cross-calibration will permit the translation of the detector measurements in cpm to gamma exposure rates in units of micro-R per hour (μR/hr) in air. Cross-calibration measurements will be performed daily at up to three known "hot spots" by taking co-located NaI detector and ion chamber reading at one meter above the hot spot for a period of time sufficient to obtain a stable reading (3 to 5 minutes for the ion chamber). Such multiple point field calibrations are desirable since the NaI detector is much more energy dependent than the ion chamber. The derived conversion factor accounts for the differential energy of the gamma photons that penetrate the ground and those from the Cs-137 calibration source. Since the depth and isotopic distribution of the contamination (and therefore the energy of the penetrating photons) may vary across the site, a mean conversion factor is derived from measurements at several locations.

All grid sampling points will be surveyed using a kinematic "stop and go" Global Positioning System (GPS) survey. With this type of survey, the grid sampling points can be located to an accuracy of greater than 0.1 feet in less than one minute. To achieve these results a minimum of four satellites are tracked at all times; additionally, two ground-based receivers must be placed at known positions. The coordinate positions of these two stations must be specified to within two inches.

Surveying is accomplished by a crewman with a backpack receiver and antenna. The antenna is placed on the ground at the location to be surveyed. The elevation and northing and easting coordinates of each point are then electronically recorded.

6.3 Soil Borings and Sample Analyses

The planned soil investigation will include the following activities. Each of these are described below:

- Locating "hot spot" biased boring locations
- Surface geophysical survey
- Drilling and soil sampling
- Downhole radiological logging
- Analysis of soil samples
- Contingency sampling and analyses
- Backfilling of boring and disposition of drill cuttings

6.3.1 Locations

All soil borings are to be drilled using a large diameter auger. A total of 50 soil borings are planned; 18 will be located within or about Area 1, and 32 within or about Area 2. Each boring is scheduled to be terminated within the underlying, undisturbed alluvium. Contingency soil borings may be performed if the soil analytical data from the planned soil sampling and analyses indicate that further characterization of the landfill is necessary. Eight of the planned soil borings will be completed as groundwater monitoring wells. The USEPA will be consulted in assessing whether further characterization is necessary.

Based on review of aerial photographs, previous investigation findings, and the anticipated drilling of 5 "hotspot" borings, as identified from the planned overland survey, 24 of the planned borings will be biased sampling locations. The remaining 26 borings will be selected using a stratified random sampling scheme. If more than 5 hotspots are identified then some of the planned stratified random boring locations will be re-located and designated as additional hotspot borings. The distribution of the biased borings within Areas 1 and 2 are as follows:

Area 1

Locations based on aerial photographs:	2 borings
Locations based on previous radiological data:	2 borings
Perimeter groundwater monitoring well locations:	3 borings
"Hot-spots" from planned radiological survey:	2 borings
Area 1 Biased Borings	9 borings

Area 2

Locations based on aerial photographs:	4 borings
Locations based on previous radiological data:	3 borings
Perimeter groundwater monitoring well locations:	5 borings
"Hot-spots" from planned radiological survey:	3 borings
Area 2 Biased Borings	15 borings

Planned soil boring locations are shown on Figure 6-2. Table 6-2 provides the coordinates, anticipated termination depths, and the rationale for the planned biased soil borings. All soil boring locations, both biased and stratified random, will be reviewed and approved by the USEPA prior to drilling.

Each planned soil boring location will be surveyed twice. The initial survey will be to identify a location for performing the planned geophysical survey. This survey will delineate areas near the tentative boring location that have minimal subsurface ferromagnetic obstructions. The second survey will be conducted after the boring has been drilled and backfilled.

All surveying will be performed by a licensed surveyor and include ground surface elevation and northing and easting coordinates referenced to an existing on-site monument located at the northeast corner of the weigh station, along the St. Charles Rock Road entrance. Each location will be surveyed for elevation to an accuracy of 0.01 feet, and northing and easting coordinates to the nearest 0.1 feet.

Figure 6-2 Map Showing Biased Soil Boring Locations

Table 6-2 Locations and Rationale for Planned Biased Soil Borings

6.3.2 Surface Geophysical Survey and Preliminary Landfill Gas Evaluation

Prior to the drilling of the soil borings, a surface geophysical survey (total magnetics) will be performed at each of the planned boring locations. The survey will encompass an area defined by a 15-foot radius circle from the identified boring location. The purpose of the survey is to define a location within this area with the least amount of potential ferromagnetic debris. This will be the location of the planned soil boring.

Concurrent with the geophysical survey will be a utility clearance to determine the potential presence of underground utilities at the planned boring locations. Boring locations will be relocated to adjust for the presence of underground and aboveground utilities if identified.

After completion of the geophysical survey and utility clearance, a landfill gas sample will be collected at one or more depths at each boring location using a probe. This sample will be analyzed for methane concentration. The results of these analyses, together with previous landfill gas data collected by Laidlaw at the adjacent Bridgeton Sanitary Landfill, will be used to define appropriate health and safety procedures for the drilling program. The results of these analyses may also impact planned boring locations and precautionary measures to be implemented during the drilling. All planned soil borings and wells will be drilled and abandoned in accordance with applicable Missouri regulations.

6.3.3 Drilling and Soil Sampling

Drilling and soil sampling will be accomplished using a large diameter, truck mounted auger. This type of drill rig is recommended because rock, concrete, and large metallic objects may be present in the landfill underlying Areas 1 and 2. The presence of these objects will limit the use of a small diameter hollow-stem auger, or other drilling equipment. Drilling will be initially performed using a 12-inch diameter auger bit. If obstructions are encountered, then the a larger bit will be used to advance the boring beyond the obstruction to the planned termination depth. The planned maximum bit size is 36-inch diameter.

With the large diameter auger, drilling is accomplished using a 3-foot to 7-foot long auger bit which is attached to a telescoping kelly. Borings are generally drilled un-cased. Soil cutting are removed from the boring on the auger bit and discharged onto the ground surface. The removed soil is generally representative of the bottom two to three feet of the boring. Soil materials from the boring are continuously, visually evaluated and can be monitored for VOCs using a Foxboro organic vapor analyzer (OVA), methane using a GasTech combustible gas indicator (lower explosive limit/oxygen meter [LEL/O_2], and radioactivity using a Geiger-Muller counter.

Soil samples for potential laboratory analyses will be collected from each boring at 5-foot intervals from the bottom of the large diameter auger drill bit. Each sample will be placed in an appropriate container, and handled in accordance with the procedures identified in Section 4 of the SAP. For each sample retained for potential laboratory analysis, a second sample will be collected and temporarily placed in a disposable, resealable plastic bag. This second sample will be used to determine field VOC headspace concentrations, lower explosive limit (LEL), percent methane, oxygen, and carbon dioxide, and measurable radioactivity. Contingency soil sampling may occur at any depth in the boring. Please refer to Section 6.3.6 for discussion on conditions which will trigger contingency soil sampling and the collection of perched water samples.

A detailed lithologic log will be prepared during the drilling of each boring using Unified Soil Classification System nomenclature. Soil descriptions will include color, based on Munsell soil color charts; percent fines, sand, and gravel; field determined plastic characteristics of the fine fraction; grain size and grading of sand and gravel fraction; relative moisture content; and the presence of distinguishing features which may be indications of in-place or man-made deposits. In-place indications include: sedimentary structures such as bedding, vegetation and roots, blocky structure, etc. Man-made deposits can be expected to include: trashy debris and rubbish, concrete, brick, rock, especially limestone from the former quarry operations, wood and other construction materials, non-native vegetation, etc.

6.3.4 Downhole Radiological Logging

Downhole radiological logging is to be performed in each soil boring. The planned survey will be performed to determine the vertical distribution of radiological contaminants, and to identify soil samples for laboratory analysis. Downhole data from borings located along the perimeter of Areas 1 and 2 will additionally provide radiological data for assessment of background conditions. Logging will be performed using a 3/8"x3/8" sodium iodide (NaI) detector with a portable single channel analyzer (SCA) or multi-channel analyzer (MCA). The detector will be equipped with a collimeter to ensure that the photons detected originate from the nearest boring wall.

Testing is performed through 2-inch diameter PVC casing which is temporarily placed and positioned along the northern-most sidewall of each boring. The NaI detector is attached to a cable and initially lowered to the bottom of the casing. The instrument is then withdrawn and measurements recorded at one foot increments starting at the bottom. The scaler to be used is a Ludlum Measurements Inc. Model 2200 or Model 2350 which can be operated in either the scaler or count rate mode. These devices are hand-held units that can be operated using an internal battery supply. The operating procedures for these units (which will be provided to EPA prior to the initiation of field work) are described in the manufacturer's operating manuals[1]. The analyzer will be set up with an energy threshold of approximately 100 keV and an open energy window. The detector is calibrated semi-annually with a Cs-137 source to verify the relationship between cpm and exposure rate (about 30 cpm/uR/hr). Calibration of the detector is performed at a licensed calibration facility.

Down-hole gamma logging using the NaI detector is currently scheduled to be used only to identify the vertical extent of radioactive contamination beneath Areas 1 and 2. However, the NaI detector can additionally be used in the field to infer the speciated concentration of many of the radionuclides of interest based on information obtained by radionuclide analysis of a number of representative samples. Gamma spectroscopy using a germanium detector can be used in the field to directly determine the speciated concentration of the radionuclides. The only radionuclide that cannot be quantified in the field by gamma spectrometry is Th-230, which is not a gamma emitter.

Use of direct reading instruments for field quantification of radionuclides will be explored as part of the planned field activities. If a constant relationship between the concentration of the various radionuclides present at the site can be demonstrated in a number of the initial soil borings using radiochemical analysis, then it will be proposed that these analyses be performed in the field and that the number of radiological soil samples analyzed in the laboratory be reduced. USEPA approval will be sought and obtained prior to any changes in analytical methods.

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[1] Ludlum Measurements, Inc., Sweetwater, Texas. Operating Manual for the Ludlum Model 2200 Single Channel Analyzer; Operating Manual for the Ludlum Model 2350 Data Logger.

6.3.5 Analysis of Soil Samples

The overland radiological survey will provide the basis for selecting 5 "hot spot" boring locations, and the downhole radiological survey will provide the basis for selecting soil samples for laboratory analyses of radionuclides. Two samples from each of the 50 planned soil borings will be analyzed for the four primary radionuclides (uranium-235 and 238, thorium-230, and radium-226). One sample from each of the 5 "hot-spot" boring locations will be analyzed for the additional radionuclides of interest (uranium-234, protactinium-231, actinium-227, lead-210, and thorium-232).

One soil sample from each boring will correspond to the soil sample collected at/near the radiological high, as determined by the downhole survey. The second sample will be collected immediately below the base of the radiologically elevated interval, or the base of the landfill debris, if elevated readings are not detected in the boring.

Selected soil samples from Areas 1 and 2 will also be analyzed for the non-radiological chemicals of concern (VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). One soil sample from 18 of the 50 planned borings will be analyzed for these compounds. The soil borings selected for analysis include the six biased borings identified based on review of aerial photographs, and 12 selected borings located within the interior of Areas 1 and 2. The 18 borings to be sampled will be evenly distributed throughout these areas to allow adequate assessment of the landfill.

Soil samples for non-radiological chemicals of concern will be collected from the lower portion of the landfill debris, and generally at the same depth as the lower radiological sample in the selected boring. The location of the 18 borings selected for analysis of non-radiological chemicals of concern will be subject to approval by the USEPA prior to the start of the drilling program.

The laboratory(s) for analysis of radiological and non-radiological chemicals of concern has not been selected at this time. Standard operating procedures for the selected laboratory(s) will be forwarded to the USEPA for review and approval prior to the start of the field investigation. Laboratory analyses will be performed at "Analytic Level III" for both radiological and non-radiological chemicals of concern.

6.3.6 Contingency Sampling and Analyses

If during the drilling of a boring, groundwater seepage is encountered within the landfill deposits, or at the base of the landfill, then drilling will temporarily stop and an attempt will be made to obtain a water sample using a hydropunch sampler. If attempts are unsuccessful, then a representative sample of the saturated soil will be collected, and retained for laboratory analyses. Laboratory geotechnical testing of clayey fine grained soils beneath perched water may be tested for permeability if the thickness of this clayey unit is 5 feet or greater. Permeability testing is the preferred test method; however, if the soil samples are disturbed and unsuitable for testing, then the permeability will be estimated based on grain size analysis and a hydrometer test.

Contingency soil sampling will occur primarily in response to encountering perched water as indicated above, or observations during drilling which suggest the possible presence of an unknown hazardous chemical compound. Drilling observations which may trigger contingency soil sampling and analyses will be based on visual observations (presence of dark or light color semi-solids, oily film on soil, multi-colored soil, crystalline structure, leaking drums, etc.), olfactory indications, or field monitoring data (e.g. significant change [10x] in OVA readings compared to other measurements in the boring).

Contingency samples will generally be analyzed for the complete suite of non-radionuclide chemicals of concern (VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide); however, conditions that trigger the collection of a sample may also be used as a basis for limiting the number at analyses to be performed. The USEPA will be consulted and approval will be obtained prior to a reduction in the types of analyses to be performed.

Contingency sampling will trigger the collection and analysis of a second soil sample from that boring. This sample will be collected to confirm the vertical extent of possible contaminants and will be collected at the base of the landfill, or within the underlying alluvium at a depth which is expected to be below possible soil contamination. This sample will be analyzed for only those compounds which are detected above the established background concentrations in the contingency sample. Contingency soil samples will be analyzed on a rush basis to ensure that they are analyzed within the proper holding times.

6.3.7 Backfilling of Boring and Disposition of Drill Cuttings

Soil cutting from the drilling of the borings will be placed on heavy duty plastic sheeting within 10 feet of the boring. If during the drilling of the borings, visual observations (presence of dark or light color semi-solids, oily film on soil, multi-colored soil, crystalline structure, leaking drums, etc.), olfactory indications, or field monitoring data (e.g. significant change [10x] in OVA readings compared to other measurements in the boring) suggest the possible presence of hazardous chemical compounds, then efforts will be made to segregate the soil into separate piles. Efforts to segregate the radiologically impacted soil will occur also, if possible. All soil piles will be covered with plastic sheeting, and sandbags will be placed on the plastic sheeting to secure the plastic.

Disposal of soil cuttings will be based on the results of soil samples collected and analyzed from each boring, visual observations, and monitoring data. A plan for disposal of the drill cuttings will be developed and submitted to the USEPA for review within 60 days of completion of the soil borings. This plan may include additional laboratory analyses to characterize the soil piles.

All borings will be backfilled with cement slurry using a tremie pipe placed at the bottom of the boring. All borings will be backfilled in accordance with the state of Missouri regulations.

6.4 Groundwater Monitoring Well Construction, Elevation Monitoring, and Sampling

The planned groundwater investigation will include the following activities. Each of these are described below:

- Evaluation of planned well locations
- Pre-drilling at planned monitoring well locations
- Drilling and construction of monitoring wells
- Development of newly constructed and selected existing monitoring wells
- Groundwater elevation monitoring
- Groundwater sampling and analyses
- Aquifer testing

6.4.1 Locations

Groundwater wells are scheduled to be placed around the perimeter of Areas 1 and 2. Some of the currently planned well locations may change based on the results of the overland gamma survey, soil analytical data from the planned perimeter borings, and confirmation of groundwater flow direction. All monitoring wells will be screened within the alluvium and completed as shallow, intermediate depth, and deep wells. The wells will be constructed generally similar to the existing on-site wells (please refer to Section 6.4.3 for well design). All monitoring well locations will be submitted for approval to the USEPA prior to drilling and construction.

No bedrock wells are planned at this time; if required for chemical characterization, they will be completed as contingency wells. Contingency wells have also been identified for the interior of Areas 1 and 2, if required to confirm groundwater flow direction. Contingency monitoring well construction may also occur if selected existing monitoring wells near Areas 1 and 2 are damaged and non-usable for monitoring and sampling purposes.

Monitoring well locations planned for each of the three depth intervals are shown on Figures 6-3, 6-4, and 6-5. Included also on these figures are the locations of existing monitoring wells completed at similar depth intervals which can potentially be used for groundwater monitoring and sampling. Locations of planned staff gages in the surface water body located north of Area 2 are also shown on these figures. The planned new monitoring wells will be distributed as follows around the perimeter of Areas 1 and 2:

<u>Area 1</u>

Shallow:	3 wells
Intermediate Depth:	2 wells
Deep:	2 wells

<u>Area 2</u>

Shallow:	4 wells
Intermediate Depth:	4 wells
Deep:	3 wells

Figure 6-3

Figure 6-4

Figure 6-5

6.4.2 Pre-Drilling at Planned Monitoring Well Locations

Each of the planned monitoring well locations will be pre-drilled to the base of the landfill using a large diameter auger. Pre-drilling will remove landfill debris which may potentially interfere with the well construction activities. The pre-drilled borings will be backfilled with cement slurry using a tremie prior to well drilling. An exception will occur if groundwater is encountered within the landfill, or anticipated to be within 5 feet of the base of the landfill. In these instances, the large diameter auger boring will be drilled to a depth of 10 feet below the depth that water was encountered, and a shallow monitoring well will be constructed in the large diameter boring.

Some of the pre-drilling locations will correspond to the planned soil borings, and others, specifically those located in areas where multiple wells are to be constructed (cluster wells), will be drilled after completion of the soil borings. All wells will be constructed within separate, backfilled large diameter borings which are terminated in the underlying alluvium. No multiple completion wells are planned.

At locations where multiple wells are to be constructed, each well cluster boring will be located at a minimum distance of 10 feet from the closest adjacent boring. This will minimize the effects of potential caving which may occur during the drilling, and reduce the likelihood that placement of the well sanitary seal will adversely impact the aquifer materials in the adjacent well.

Soil sampling for laboratory analyses is not scheduled to occur during the drilling of the pre-borings, except in those borings which have been previously identified for soil sampling and analyses. Soil cuttings, however, will be visually evaluated and monitored using an OVA, LEL/O_2 meter, and a Geiger-Muller counter, and a detailed lithologic log of the boring prepared. If visual observations, olfactory evidence, or monitoring data suggest the possible presence of hazardous compounds, as previously described, then contingency soil sampling and analyses may be performed. Soil samples of all suspect materials will be retained and a decision to analyze these samples will be reached after all cluster well borings at a specific location have been drilled.

Each pre-boring will be downhole radiologically logged. Downhole radiological data from these borings can potentially be used to verify and establish background conditions, and to evaluate variability in radiological readings in the landfill from several closely spaced borings.

6.4.3 Drilling and Construction of Monitoring Wells

All of the planned alluvial monitoring wells will be drilled using 10 to 12-inch diameter (O.D.) hollow-stem augers. Soil samples will be taken in the monitoring well borings at 5-foot intervals to the planned termination depth starting at a depth of five feet below the bottom of the pre-drilled boring. The planned termination depth for the shallow wells is 10 feet below the top of the groundwater surface, as indicated by saturated soil conditions in the retrieved soil samples; while, the termination depth for the deep alluvial wells is the bedrock contact. The intermediate depth wells will be terminated at a depth which is equivalent to the average depth of the shallow and the deep wells.

For the cluster monitoring wells, only the deepest boring will be soil sampled. The planned termination depths and monitoring well design for the adjacent wells will be based on this boring. Tentative termination depths for the planned monitoring wells are presented in Table 6-3.

Each monitoring well will be constructed with 4-inch diameter, threaded schedule 40 PVC pipe and slotted well screen, unless soil samples from the pre-drilled boring indicate groundwater may be potentially impacted by halogenated VOCs at concentrations which may damage the well screen. If this situation occurs, then the wells will be constructed of 4-inch diameter low carbon steel with a stainless steel well screen.

The shallow wells will be constructed with a three foot cellar, 20 feet of well screen (placed 10 feet above and 10 feet below the groundwater surface), and solid pipe which extends approximately two feet above the ground surface. The intermediate and deep wells will be constructed similarly; however, the well screen will be 10 feet long. The well screen slot size and filter pack for all wells will be determined after performing a sieve analysis of the soil samples collected from the planned screen interval. Testing will be performed in the field, and the driller will have available a variety of well screen sizes (0.010, 0.020, and 0.030 inch), and appropriate sand pack materials for use with these screens.

Construction of the monitoring wells will be through the hollow-stem augers. Filter pack materials will extend approximately two feet above the top of the well screen, and a two foot bridge of hydrated bentonite will be placed above the filter pack. Neat cement grout will extend from the bridge to the ground surface.

Table 6-3

Steel protective casing with a 2 to 3 foot stickup will be driven in-place over the top of the casing. The casing will be covered with a cap, and the protective casing with a locking cover.

The top of well casing, top of protective steel casing, and the ground surface at all well locations will be surveyed for elevation, and northing and easting coordinates after completion of the wells. All surveying will be performed by a licensed surveyor and referenced to an existing on-site monument located at the northeast corner of the weigh station, along the St. Charles Rock Road entrance.

6.4.4 Development of Newly Constructed and Selected Existing Monitoring Wells

All newly constructed wells will be developed using surge block, bailing, and pumping techniques. A minimum of 10 casing volumes of water will be removed during well development. During development, physical parameters, pH, electrical conductivity, temperature, and turbidity, will be monitored. Development will continue until these physical parameters have stabilized and the water is non-turbid (<30 Nephelometric Turbidity Units [NTUs], unless this turbidity level is not achievable, based on field measurements, and an agreed change is approved by the USEPA). Stabilization is achieved when pH is constant and to within 0.1 pH unit, conductivity does not vary by more than 10 percent from the previous reading, and the temperature does not vary by more than 1 degree centigrade. Development water will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

Existing wells suitable for use as groundwater elevation monitoring wells, and possibly for the collection of groundwater samples and analyses, will be re-developed to remove sediment that may have accumulated in the bottom of the well, and to ensure that the purged water is non-turbid. A minimum of 10 casing volumes of water will be removed during well development. Development water will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

6.4.5 Groundwater Elevation Monitoring

Each well will be monitored using an electronic water sounding device to an accuracy of 0.01 feet. Groundwater elevation monitoring of existing and newly constructed wells will be performed on a monthly basis during the course of this investigation. Existing wells which are to be used for groundwater elevation monitoring will be re-surveyed for elevation, and northing and easting coordinates.

Water elevation data collected prior to the construction of new wells will confirm groundwater flow direction. Elevation data collected on multiple dates will be useful for assessing changes in groundwater elevation and flow direction which may occur seasonally, or in response to a rainfall event.

During the initial sounding of each well, an oil/water interface probe will be used to determine whether free-phase hydrocarbons are present in groundwater.

Staff gages located within the surface water body north of Area 2, and other locations will be surveyed and monitored on a monthly basis as part of the groundwater monitoring program. Please refer to Section 6.8 for locations of planned staff gages.

6.4.6 Groundwater Sampling and Analyses

Two rounds of water quality sampling are planned for the newly constructed and selected existing wells. Prior to the collection of the samples, each well will be purged to remove a minimum of three casing volumes. Physical parameters (pH, temperature, electrical conductivity, and turbidity) will be monitored during well purging. If field parameters have not stabilized after the removal of three casing volumes, then additional water will be removed until stabilization is achieved. Stabilization is achieved when pH is constant and to within 0.1 pH unit, conductivity does not vary by more than 10 percent from the previous reading, and the temperature does not vary by more than 1 degree centigrade.

Sampling of all wells will be performed within a three to five day period. The initial sampling round will occur approximately two weeks after well completion and development. The second sampling round will occur six to eight weeks after the initial sampling.

Prior to the second sampling round, water quality analytical data from the newly constructed and existing wells will be evaluated. Based on this evaluation, a change in the number and location of existing wells to be sampled may occur. USEPA approval will be obtained, prior to any changes in the existing wells to be sampled. All newly constructed wells will be sampled during this second sampling round.

Existing monitoring wells tentatively scheduled for sampling are identified below. The wells selected may change based on the condition of the wells, as determined during the initial assessment of each well, or groundwater elevation data collected after construction of the new groundwater wells.

Shallow Wells: S-60, S-61, S-84, MW-101, and MW-106

Intermediate Depth Wells: I-62, I-65, I-66, I-67, and I-68

Deep Wells: D-83, D-85, D-93, and D-94

Groundwater samples from all wells will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). In addition, the sample collected from MW-106 will be analyzed for thorium-232 to verify the results of previous analyses from this well. Priority pollutant metals and radionuclide analyses will be performed on both filtered and unfiltered samples during the initial sampling round, and unfiltered samples during the second sampling round. Filtered analyses may also be performed on selected wells for selected metals during the second sampling round. QA/QC samples (trip blanks, field blanks, and duplicates) will be prepared/collected and analyzed during each sampling round.

Water generated during the purging of the wells will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

6.4.7 Aquifer Testing

Aquifer testing will consist of performing slug tests on all newly constructed wells. Slug tests provide a rapid, cost effective means of determining the hydraulic conductivity of aquifer materials in the immediate vicinity of the well boring. An appropriately sized slug will be used to perform the slug tests. The diameter and length of the slug will be sufficient to create a minimum of 2 to 3 feet elevation change in groundwater level. During the test, monitoring of both rising head and falling head conditions will be performed using a pressure transducer. As a contingency, aquifer testing by a pump test may be considered if water quality data from the wells indicate the need for additional testing. All aquifer testing equipment will be decontaminated prior to placement in the monitoring wells.

6.5 Surface Soil Cover Sampling and Analyses

Surface soil sampling of the landfill cover will be performed by collecting a soil sample from the upper 2 inches of the soil cover. Fifteen locations are to be sampled; 5 at radiological "hot-spots", and 10 at selected soil boring locations. Additional samples will be collected at any location where surface indications suggest the presence of potential contamination.

The 5 radiological "hot-spot" surface samples will be collected in conjunction with the drilling of the 5 radiological "hot-spot" borings, and will be collected at the same locations. The 10 additional sampling locations will be randomly selected from the soil boring locations which were selected by stratified random sampling. Additional, non-radiological samples will be collected in any areas in which surface or olfactory indications, or monitoring data (OVA and LEL/O_2) suggest the potential presence of hazardous chemicals. Surface visual indications include: staining, multi-colored soil, an unexplained damp or wet area, distressed vegetation, evaporite chemical precipitate or crust on soil, etc.

In the event that 5 radiological "hot spots" are not identified, then the remaining surface samples will be collected from randomly selected soil borings which were located by the stratified random selection process. All surface sampling locations will be submitted to the USEPA for review and approval, prior to the collection of any samples.

All surface soil samples will be analyzed for all chemicals of concern: the four primary radionuclides (uranium 235 and 238, thorium 230, and radium 226), VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide.

In addition to the laboratory chemical analyses, all surface soil samples will be analyzed for the following geotechnical parameters: moisture, density, and percent relative compaction.

6.6 Leachate Sampling and Analyses

The slope faces (berms) that bound Areas 1 and 2 will be examined for the presence of seeps on a weekly basis during the time the field investigation is occurring. All seeps that are identified will be sampled. If the volume of seepage is inadequate for the collection of a surface discharge sample, then sampling will include the installation of one or more lysimeters at each seep location.

Leachate samples will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). Metal analyses will be performed on unfiltered samples, and also filtered samples if a sufficient quantity of liquid is obtained. In addition to the above analyses, leachate samples will be analyzed for biological oxygen demand, chemical oxygen demand, pH, total dissolved solids, total organic carbon, chlorides, nitrite, nitrate, ammonia, total phosphorous, and sulfide. If a sufficient quantity of liquid cannot be obtained, then a sample of the saturated soil will be analyzed for those chemicals of concern and parameters which could not be analyzed from the liquid sample. Chemical analyses of liquid samples will be prioritized based on the quantity of liquid available for testing, the analytical requirements, and the analytes which may have been detected in soil borings drilled through the landfill.

6.7 Rainwater Run-Off and Erosional Sediment Sampling and Analyses

A map showing the locations of planned rainwater run-off and erosional sediment samples is presented as Figure 6-6. These sampling locations are based on drainage patterns as determined from the site topographic map and will be confirmed during the site surveillance. If the site reconnaissance indicates additional locations where rainwater accumulates and flows off-site, then these additional areas will also be considered for possible sampling and analysis. All sampling locations will be confirmed with the USEPA prior to the collection of samples.

Rainwater run-off samples will be collected within 24-hours of a rainfall event which produces, or is anticipated based on weather forecasts to produce, greater than 1-inch of rainfall at nearby Lambert Field airport, and generates a sufficient quantity of run-off for collection of samples. At the planned sampling locations, flow will be directed through a calibrated "V-notch" weir, or a pipe to estimate flow volume at the time of sampling. Water samples will be collected on the upstream side of the weir, or from the pipe using appropriate sampling containers as described in section 4 of the SAP. Temperature, pH, and specific conductance, hardness and dissolved oxygen will be measured directly in the field at each sampling location or in a separate beaker, as necessary.

After collection of the rainwater run-off samples, the weirs will be removed. Sediment samples will be collected within 24-hours after the rainfall event at the location where the "V-notch" weir, or pipe was previously located. Sample collection and handling will be performed consistent with the procedures outlined in Section 4 of the SAP.

Figure 6-6 Tentative Rain Water Runoff and Erosional Sediment Sample Locations

Rainwater run-off samples will be analyzed for the complete suite of chemicals of concern, except priority pollutant metals (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, and cyanide). Radionuclide metal analyses will be performed on both unfiltered and filtered samples. Priority pollutant metal analyses are not being performed on rainwater runoff samples because erosional sediments are to collected at the same location, and the sediment samples will provide a better indication of whether or not metals are being transported offsite by rainwater run-off.

Erosional sediment samples will include all of the chemicals of concern, except the VOCs (uranium-235 and 238, thorium-230, radium-226, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide).

6.8 Surface Water Sampling and Analyses

Surface water samples will be collected from the surface water body located immediately north of Area 2, and any other low-lying water drainage retention area receiving rainwater run-off from Areas 1 and 2, or any leachate from these areas (see Figure 6-3). Surface water sampling will be performed approximately three days after the end of a precipitation event in which an accumulation of greater than one inch is recorded at nearby Lambert Field airport. Sampling after a significant rainfall event will ensure that the majority of the water contained in these surface water bodies originates from the Site and is representative of surface run-off.

Staff gages will be located at all planned sampling locations. The staff gages will be surveyed for elevation and northing and easting coordinates and monitored on a monthly basis in conjunction with the groundwater monitoring program.

Surface water samples will be grab samples collected in appropriate laboratory cleaned containers. Sample collection and handling will be performed consistent with the procedures outlined in Section 4 of the SAP. Two samples from the surface water body north of Area 2 will be collected; one on the upstream side of the culvert located beneath St. Charles Rock Road, and the other at the furthest upstream location receiving run-off or potential leachate from the Site. These sampling locations correspond to the locations of planned staff gages.

The surface water samples from the surface water body north of Area 2 and samples from any other identified water body will be collected from mid-depth at a midstream location, to minimize the effects of surface aeration and bank turbulence. Sampling will begin with the most downstream sampling point and will proceed in an upstream direction. The samples will always be collected upstream from the sampler's position. The sample location and depth will be recorded in the field log book. As well as the water level elevation as indicated by the staff gage located at the sampling station.

Temperature, pH, and specific conductance, hardness and dissolved oxygen will be measured in the field at each surface water location either directly from the water body or in a separate beaker, as necessary. The samples will be collected by immersing either the sample container, or a clean stainless steel or glass beaker into the water. As noted, the water will be transferred from the beaker into the appropriate sample container in a manner that minimizes aeration.

All surface water samples will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). Priority pollutant metal and radionuclide analyses will be performed on both filtered and unfiltered samples.

6.9 Geotechnical Evaluation of Area 2 Landfill Slopes (Berms)

A geotechnical investigation will be conducted to evaluate the stability of the slope (berm) on the north side of Area 2. Field work to be performed as part of this evaluation will include: collection of a minimum of four soil samples using a hand-held sampler from the face of the slope, and also from one boring drilled at the top of the landfill using a large diameter drilling rig equipped with a drive sampler (one of the planned biased soil borings can be used for this purpose); field mapping to profile the slope at several locations; and visual evaluation of any portions of the slope that have been exposed due to sloughing or erosional scour. Groundwater data from a nearby well will also be obtained to determine seasonal variations in depth to water beneath the slope.

Soil samples will be geotechnically analyzed for moisture/density, and direct shear tests will be performed to determine strength characteristics of the soil cover and the soils contained within the landfill. Building materials and miscellaneous debris present within the landfill may prevent the collection of relatively undisturbed soil samples; therefore, the samples may need to be sieved in the laboratory and remolded to field conditions prior to testing.

Geotechnical testings will also include a shear test and a consolidation test on an undisturbed soil sample of the alluvium from beneath the landfill. If obstructions within the landfill prevent drilling to the desired depth, then an undisturbed sample will be collected outward from the toe of the slope using a hand-auger and drive sampler and the sample retained in a brass rings for testing.

Using field and laboratory data, the stability of the soil cover and the landfill mass will be determined using graphical methods, or using one of the various computer software programs available.

6.10 Radon Sampling and Analysis

Radon flux measurements will be collected during two rounds of sampling at five locations in Areas 1 and 2. Samples will be taken at one radiological "hot spot" in each of these areas; the three remaining locations will be randomly selected, one in Area 1 and two in Area 2. If no "hot spots" are identified, then all five samples will be randomly located.

The radon sampling rounds will be separated by as much time as practical to permit sampling under different meteorologic conditions. The initial sampling will be performed prior to mobilization of drilling equipment to the Site to acquire health and safety data. Sampling will be performed using charcoal-based radon canisters suspended in an inverted container such as a plastic bowl or bucket. The approach will be to trap radon emanating from the ground and collect essentially 100% of the radon with the charcoal canister.

Each canister/container assembly will be left in place for 2 days. The canisters will then be sent off-site for laboratory analysis. The activity of radon based on the gamma measurements is then converted to radon flux (pCi/m^2-sec) by dividing the activity by the area of the collector (m^2), the amount of time the canister was left in place, and a decay correction factor.

drilling to the desired depth, then an undisturbed sample will be collected outward from the toe of the slope using a hand-auger and drive sampler and the sample retained in a brass rings for testing.

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Each canister/container assembly will be left in place for 2 days. The canisters will then be sent off-site for laboratory analysis. The activity of radon based on the gamma measurements is then converted to radon flux (pCi/m^2-sec) by dividing the activity by the area of the collector (m^2), the amount of time the canister was left in place, and a decay correction factor.

6.11 Landfill Gas Sampling and Analysis

Landfill gasses will be evaluated for site characterization, risk assessment, and also for health and safety purposes during the remedial investigation. With regards to site characterization and risk assessment, three potential air contaminant concerns have been identified at the Site. The first concern is the generation of radon from the decay of radioactive waste, the second is the potential presence of landfill gas and other non-radiological volatile chemicals of concern, and the third is fugitive dust.

Radon flux measurements will be taken in both Areas 1 and 2 of the site. Flux measurements will be taken at identified radioactive "hot spots" and at other locations that are randomly selected. Samples will be collected using commercially available, charcoal-based radon canisters suspended in an inverted container such as a plastic bowl or bucket. Each canister/container assembly will be left in place for 2 days to determine average radon flux levels at the Site. Two rounds of sampling will be conducted, with the intent of having the sampling rounds separated by a significant amount of time so that radon flux under two different sets of meteorologic conditions can be established.

The second issue related to airborne contamination is the potential for the presence of landfill gas. Migrating landfill gas can potentially contaminate groundwater or be released to the air. As part of efforts to characterize the nature and extent of non-radioactive contamination in Areas 1 and 2, a landfill gas sample will be collected at each planned boring and well location using a probe (methane analyses only). Eight additional air samples will be collected from the surface of the landfill using a flux chamber. These additional samples will be analyzed for volatile organic chemicals of concern.

The third airborne concern is entrainment of contaminants in fugitive dust. Sampling of fugitive dust from non-vegetated areas and roadways will be performed in conjunction with the landfill gas sampling program.

The preliminary list of remedial alternatives is as follows:

1) No Action.

2) Access Restriction

3) "Hot Spot" Excavation Treatment.

4) Surface Capping

5) Institutional Controls/Long-term Monitoring.

6) Containment/Leachate Control/Landfill Gas Control/Institutional Controls/Long-term Monitoring.

7) Containment/Groundwater Control and Treatment/Consolidation of Contaminated Soils/Sediments/Landfill Gas Control/Institutional Controls/Long-term Monitoring.

Table 7-5 listed and described remedial technologies which may comprise components of the aforementioned preliminary remedial alternatives. It should be reiterated that the list of remedial alternatives is preliminary in nature and based on the limited data gathered to date. The development of remedial alternatives which are screened and analyzed in detail against USEPA's nine evaluation criteria for remedy selection will be conducted during the FS, once the nature and extent of contamination has been more definitively determined.

This task will be conducted in accordance with activities set forth in the AOC/SOW and will include preparation and submittal to USEPA of a technical memorandum entitled:

- Development and Screening of Remedial Alternatives Technical Memorandum.

7.5 Data Requirements

Data quality objectives and the remedial investigation tasks have been described previously in Sections 5 and 6, respectively.

TABLE 4-2

CONTAMINANT TRANSPORT/MIGRATION POTENTIAL

Class of Contaminant	Environmental Media - Contaminant Migration Potential		
	Waters- Ground & Surface	Soils[1]/ Sediments	Air
Uranium & Decay Products	Moderate	Low	Low (High for Radon)
Volatile Organics	High - Groundwater Low - Surface Water	Low	High
Semi-Volatile Organics	Moderate	Low	Low
Metals	Low to Moderate	Low	Low
Chlorinated Pesticides	Low	Low	Low

[1] A soil cover has been placed over the landfill and the potential for migration of soil beneath the landfill is considered low. A slope failure had locally occurred near the Ford property and has been mitigated by the placement of additional soil cover. The migration potential for this localized slope debris on the Ford property is higher.

TABLE 4-3

POTENTIAL CONTAMINANT EXPOSURE ROUTES TO BE ADDRESSED

Environmental Media	Receptor		
	General Public	On-site Workers/Intruders	Ecological
Groundwater	X		
Surface Water	X		X
Soils/Sediments	X	X	X
Air	X	X	X

TABLE 5-1

PRELIMINARY REMEDIAL ACTION OBJECTIVES

Media	Potential Areas Requiring Response	Contaminants of Concern	Preliminary Remedial Action Objectives
Soil	The Site and adjacent property.	See groundwater.	Prevent migration of soil contaminants which would result in exposure or groundwater concentrations in excess of ARARs or that pose unacceptable risk.
Erosional Sediment and Surface Water	Surface water run-off areas on and adjacent to the Site.	See groundwater.	Prevent release of contaminants from sediments and rain water run-off that would result in exposure in excess of chemical-specific ARARs or that pose unacceptable risk.
Groundwater	The Site and areas downgradient.	Radionuclides; Organic chemicals; and Inorganic chemicals.	Contain or control offsite migration of contaminants in groundwater that are at concentrations in excess of ARARs or that pose unacceptable risk (e.g. capture, isolation, etc.)
Air	At perimeter of the Site.	Radon; Radioactive particles; Organic and Inorganic Chemicals	Prevent/mitigate the release of contaminants to the air in concentrations that would exceed ARARs or pose unacceptable risk.

TABLE 5-3

DATA QUALITY NEEDS

Work Plan Activity	Data Uses	Analytic Level	Critical Samples
Geotechnical Investigation	-Site Characterization -Evaluation of Alternatives	Level III	
Hydrogeologic Investigation	-Site Characterization	Level II	
Surface Gamma Survey	-Site Characterization -Health & Safety	Level I	Local background
Down-Hole Gamma Survey	-Site Characterization	Level II	Local background
Subsurface Soil Sampling & Analysis	-Site Characterization -Risk Assessment	Level III	Local Background Field Duplicate
Surface Soil/Erosional Sediment Sampling & Analysis	-Site Characterization -Risk Assessment	Level III	Local Background Field Duplicate
Leachate/Surface Water Sampling & Analysis	-Site Characterization -Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank
Ground Water Sampling & Analysis	-Site Characterization -Risk Assessment	Level III	Local Background Field Duplicate Rinsate Blank Trip Blank
Landfill gas	-Health & Safety -Site Characterization -Risk Assessment	Level III	
Radon	-Health & Safety -Site Characterization -Risk Assessment	Level III	

TABLE 5-4

DATA QUALITY OBJECTIVES

Contaminant	Level of Concern (PRGs)		Literature Background		Reporting Limits	
	Industrial Soil (mg/kg)	Tap Water (ug/l)	Soil (mg/kg)	Water (pCi/l)	Soil (mg/kg)	Water (ug/l)
Volatile Organics						
Acetone	4,300	770	---	---	0.1	100
Methylene Chloride	15	5	---	---	5	5
TPH	50-500	5	---	---	10	0.5
Semi-Volatile Organics						
Bis(2-ethylhexyl) phthalate	400	1	---	---	0.3	10
Hexachlorobenzene	4	0.04	---	---	0.3	10
Phenol	100,000	4,600	---	---	0.3	10
Metals						
Antimony (and Compounds)	820	6	<1-2[a]		20	6
Arsenic	3	20	1.9-15[a]		0.3	3
(Free) Cyanide	41,000	730			0.5	0.01
Iron	NA	NA	100- >100,000[a]		5	50
Lead		15	10-50[a]		15	3
Nickel (and Compounds)	41,000	100	≤30[a]		8	75
Sodium	NA	NA	≤100,000[a]		100	1000
(Thallic Oxide) Thallium	140	2			50	3
Zinc	100,000	11,000	25-108[a]		2	20
Chlorinated Pesticides						
Chlordane	4	0.05	0.04-4[c]		0.004	0.14
4,4'DDD	20	0.07			0.004	0.1
4,4'DDE	20	0.05			0.001	0.04
4,4'DDT	20	0.02			0.004	0.1
Dieldrin	0.4	0.001	0.01-6[c]		0.0007	0.02
Endrin	600	0.2			0.002	0.06

TABLE 5-4

DATA QUALITY OBJECTIVES

Contaminant	Level of Concern (PRGs)		Literature Background		Reporting Limits	
	Industrial Soil (mg/kg)	Tap Water (ug/l)	Soil (mg/kg)	Water (pCi/l)	Soil (mg/kg)	Water (ug/l)
(HCH gamma) Lindane	4	0.2			0.001	0.04
Radionuclides						
Ra-226	0.03	5	0.3-1.4[a]	5[b]	2	0.2
Th-230	200	0.0004			1	1
U-234	170	0.0005			1	1
U-235	0.7	0.0005			1	1
U-238	5	0.0002	0.3-2[a]		1	1

a Dragun, J., & Chasen, A., *Elements in North American Soils*, Hazardous Materials Control Resources Institute, greenbelt, MD, 1991.

b Lothern, Richard, C., Reberts, Paul A., *Randon, Radium and Uranium in Drinking Water*, Lewis Publishers, Chelsea, Michigan, 1991.

c USEPA Office of Pesticide and Toxic Substances Cropland Soil Monitoring Program, 1972.

TABLE 6-1

REMEDIAL INVESTIGATION OBJECTIVES

ACTIVITY	OBJECTIVES	ACTION
Field Surveillance	Identify site features that will potentially affect investigations/remediation.	1. Characterize surface features and geologic features at the site. 2. Identify areas of surface water collection & run-off. 3. Identify areas of off-site erosion and sediment flow. 4. Evaluate site for habitat for threatened or endangered species. 5. Characterize residential and commercial development in the area (i.e., locations of potential receptors) and nearest private water wells. 6. Inspect soil cover and slopes in Areas 1 and 2 for evidence of contamination and designate as surface soil sampling location.
Geotechnical Investigation	Collect geotechnical data on soil characteristics to establish stability of landfill slopes (berms) and soil cover to support evaluation of remedial alternatives.	Collect data on soil moisture/density, shear strength, and compressibility.
Hydrogeologic Investigation	Determine groundwater flow direction and rate for the purposes of site characterization and risk assessment.	1. Evaluate existing wells for use in investigation. 2. Install wells at selected points around landfill (in some cases these will be new soil boring locations) and take water level measurements at new and existing wells. 3. Conduct "slug tests" (aquifer tests) to determine hydraulic conductivity of aquifer materials. 4. Evaluate groundwater flow direction and gradient, and approximate groundwater flow velocity.
Meteorologic Investigation	Quantify rainfall amounts to identify any surface water/groundwater relationships. Characterize wind speeds and direction at site to support assessment of remedial alternatives.	Obtain rainfall and meteorologic information from Lambert Field Airport.

TABLE 6-1

REMEDIAL INVESTIGATION OBJECTIVES

ACTIVITY	OBJECTIVES	ACTION
Contaminant Investigation		
Landfill Soils and radiological "hot spots"	Reestablish boundaries of Areas 1 and 2 based on extent of radioactively contaminated fill and locate "hot-spots" for the purposes of site characterization, also characterize radiation levels for health and safety purposes	Perform gamma surface survey.
	Investigate areal extent, depth and concentration of contaminant at radiological "hot spots" and at other locations within Areas 1 and 2 (as defined by gamma surface survey) for the purposes of site characterization.	1. Perform soil borings, using magnetometer to first determine if obstructions are likely to be encountered at planned boring locations & relocate as necessary. 2. Characterize soils in borings. 3. Perform down-hole monitoring for radionuclides. 4. Select retained soil samples corresponding to location of highest radioactivity as indicated by down-hole measurements for lab analysis of radionuclides. 5. Collect soil sample near bottom of visually identified landfill material of selected borings for non-radioactive analysis. 6. Collect and analyze contingency soil samples for nonradioactive contaminants.
	Characterize surface contamination for site characterization and risk assessment purposes.	Collect surface soil samples and analyze for radioactive and non-radioactive contaminants.
Groundwater	Identify extent and type of ground water contamination for site characterization and risk assessment and to determine need for remediation.	Complete installation of new wells to determine extent of contaminant plume, collect and analyze samples from new wells and selected existing wells. Perimeter wells to be analyzed for radioactive and non-radioactive contaminants; selected others for radionuclides and nonradioactive contaminants detected at concentrations above define background.
	Characterize up-gradient water quality or "background".	Collect and analyze samples for radioactive and non-radioactive contaminants from selected existing wells located upgradient or lateral to Areas 1 and 2.

TABLE 6-1

REMEDIAL INVESTIGATION OBJECTIVES

ACTIVITY	OBJECTIVES	ACTION
Leachate	Identify and evaluate leachate seeps from Areas 1 and 2.	Collect and analyze leachate for radioactive and non-radioactive contaminants and identified indicator parameters.
	Characterize leachate present in Areas 1 and 2.	Sample and analyze any perched water encountered during soil boring for radioactive and non-radioactive contaminants.
Erosional Sediment & Surface Water	Characterize surface water and groundwater levels over time.	Install staff gauges and measure surface water and groundwater levels concurrently.
	Determine contaminant concentrations in surface water bodies and surface water run-off.	Sample surface water from the North Water Body and run-off after a major rainfall event and analyze for radioactive and non-radioactive contaminants.
Air/Landfill Gas	Characterize radon levels in air in Areas 1 and 2 for site characterization and risk assessment purposes.	Collect and analyze radon samples.
	Characterize concentrations of methane and volatile chemicals of concern in Areas 1 and 2 for site characterization, risk assessment, and health and safety purposes.	Measure combustible gas concentrations in soil vapor, in air samples collected from the surface of the landfill, in soil borings and in the head space of samples.
	Characterize fugitive dust for site characterization and risk assessment purposes.	Collect fugitive dust samples and analze them for radionuclide and priority pollutant chemicals of concern.

APPENDIX A

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN
FIELD SAMPLING PLAN
QUALITY ASSURANCE PROJECT PLAN
FOR THE WEST LAKE SITE
BRIDGETON, MISSOURI

Prepared for:

THE WEST LAKE RESPONDENT GROUP

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1.0 INTRODUCTION

A remedial investigation/feasibility study (RI/FS) will be conducted at the West Lake property. The area of interest for this RI/FS is where previous investigations have indicated the presence of radiological contaminants; these areas are designated as Areas 1 and 2 (Site). The RI/FS will be conducted pursuant to an Administrative Order by Consent (AOC) issued by the Unites States Environmental Protection Agency, Region VII (USEPA), CERCLA Docket No. VII-93-F-005. Figure 1-1 is a map showing the location of the West Lake property. Figure 1-2 is a site location map showing the location of Radiological Areas 1 and 2 on the West Lake property.

The Respondent Group has retained McLaren/Hart Environmental Engineering, Inc. to prepare a RI/FS Work Plan and to perform the RI/FS. The Work Plan identifies the additional information and data that must be acquired to complete the RI and FS under CERCLA. The RI serves as the mechanism for collecting data to characterize site conditions; determine the nature of the waste; assess risk to human health and the environment; and conduct treatability testing as necessary to evaluate the potential performance and cost of the treatment technologies that are being considered. The RI also supports the design of selected remedies. The FS serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. The objective of the remedial actions will be to ensure protection of human health and the environment.

The Sampling and Analysis Plan (SAP) has been prepared as part of the RI/FS Work Plan. It has been prepared in accordance with applicable USEPA guidance documents and describes the sampling approach that will be implemented. A Quality Assurance Project Plan (QAPP) has been prepared as part of this SAP and is attached. A Site Safety and Health Plan (SSHP) has been prepared for implementation of the Work Plan and is presented under separate cover.

1.1 Chemicals of Concern

Radionuclides, metals, and chemical compounds have been detected during previous investigations. The chemicals of concern for the remedial investigation include four primary radionuclides (Uranium-235 and 238, thorium-230, and radium-226) and analytes that may be found in the following laboratory analytical methods: volatile organic compounds (VOCs) by EPA Method 8240; semi-volatile organic compounds (SVOCs) by EPA Method 8270; total petroleum hydrocarbons (TPH) by EPA Method 8015M; pesticides and PCBs by EPA Method

FIGURE 1-1

FIGURE 1-2

8080; priority pollutant metals by EPA method 6010/7000; and cyanide by EPA Method 9010. Although not a chemical of concern, the USEPA in a letter dated February 18, 1994, requested that selected samples be analyzed for thorium-232.

1.2 Potential Migration Pathways

Contaminants which may be present beneath the Site may migrate by the following media:

- Air
- Erosional sediment/surface water run-off
- Leachate throughflow
- Groundwater.

The environmental media which will be evaluated during implementation of the remedial investigation include the following:

- Air
- Soil
- Rainwater run-off
- Erosional sediments
- Surface water bodies
- Groundwater
- Leachate seeps (contingency)
- Landfill gas

All leachate seeps, if identified during the course of the remedial investigation, will be sampled and analyzed. The presence and type of landfill gasses that may be present will be evaluated by collection of soil vapor samples at each of the planned soil boring and well locations, and also by collection of air samples from the surface of the landfill using a flux chamber. The soil vapor samples will be analyzed for methane only; the surface air samples will be analyzed for volatile chemicals of concern and fugitive dust. During the field investigation, landfill gasses will be additionally monitored for health and safety purposes.

2.0 OBJECTIVES

The primary objective of the RI/FS is to assess Site conditions, and the risk to human health and the environment from past activities which have occurred at the Site. The specific RI/FS data objectives are identified in the Work Plan (Section 5.1). The objectives of the remedial investigation and specific activities to be performed are summarized in Table 2-1.

A summary of specific data quality needs is presented in Table 2-2. Please refer to Section 5.3.2 of the Work Plan for further discussion on data quality objectives.

TABLE 2-1

TABLE 2-2

TABLE 2-2 CONTINUED

TABLE 2-2 CONTINUED

3.0 REMEDIAL INVESTIGATION TASKS AND SAMPLING METHODOLOGY

The planned field activities include the following tasks. Each of these tasks and the procedures to be followed in completing these tasks are described below:

- Field Surveillance
- Overland Gamma Radiological Survey
- Soil Borings and Sample Analyses
- Groundwater Monitoring Well Construction, Elevation Monitoring, and Sampling
- Surface Soil Cover Sampling and Analyses
- Leachate Sampling and Analyses
- Rainwater Run-Off and Erosional Sediment Sampling and Analyses
- Surface Water Sampling and Analyses
- Geotechnical Evaluation of Area 2 Landfill Slopes (Berms)
- Radon Sampling and Analysis
- Landfill Sampling and Analysis

3.1 Field Surveillance

Immediately after mobilization to the field a reconnaissance survey of Areas 1 and 2, and adjacent areas will be performed. The purpose of this reconnaissance survey is to identify site features which may have changed since preparation of the Work Plan, and to identify site conditions which may affect the investigation and the development of remedial alternatives. Specific activities to be performed as part of the field surveillance include the following:

- Identify any changed site conditions which may impact implementation of the Work Plan.

- Verify locations for placement of staff gages and water quality sampling of the surface water body located north of Area 2. Areas of ponded surface water which may be present around the perimeter of Areas 1 and 2 will be noted, and considered for potential placement of staff gages and sampling.

- Verify rainwater run-off patterns and discharge locations, and identify areas of erosional sediment accumulation. Erosional sediments that have flowed onto the adjacent Ford property will be mapped, along with any other erosional sediments that may be present on adjacent properties. Interim measures, such as placement of fencing around any identified areas, will be considered.

- Re-inspect soil cover in Areas 1 and 2, including the adjacent slopes (berms), for evidence of potential hazardous chemical accumulation. Designate any identified locations for surface soil sampling.

- Evaluate site for habitat of threatened or endangered species.

- Identify changes in residential and commercial development which may have occurred or may be in the developmental stages (i.e., locations of potential receptors) and verify locations of nearest private wells.

- Evaluate condition of all existing groundwater monitoring wells on the West Lake property and determine whether they may be suitable for groundwater elevation monitoring and potentially for water quality sampling.

Findings and observations from the field reconnaissance will be documented in a letter and forwarded to the USEPA.

3.2 Overland Gamma Radiological Survey

3.2.1 Location

An overland gamma radiological survey will be performed to delineate Areas 1 and 2. The survey will also identify locations ("hot spots") for subsequent soil sampling and analysis. The survey will be performed on a 30-foot by 30-foot grid. This grid will extend beyond the currently defined limits of Areas 1 and 2, and will include the adjacent perimeter landfill slopes and a portion of the adjacent Ford property. Delineation of the "hot spots" may require a tightening of the grid, and this will be performed as required. Figure 3-1 identifies the location of Areas 1 and 2 and the tentative radiological survey grids.

Radiological "hot spots" are defined as areas exhibiting gamma-ray exposure rates that are a factor of two higher than the exposure rates encountered in radiologically uncontaminated areas with otherwise similar soil characteristics. Background exposure rates are the basis of comparison for defining hot spots and are expected to fall in the range of 6 to 10 uR/hr. The

Figure 3-1

average background radiation exposure rate reported by the National Council for Radiation Protection for middle America is 7 uR/hr (NCRP, Report No. 94, 1987). Local background will be established by taking a measurement off-site on the open field east of the site and east of the St. Charles Rock Road entrance to the site.

It is recognized that, as a landfill, the site likely has received soils from a variety of sources and, as a result, definition of a representative background sampling location is difficult. In order to establish a representative site-specific reference background measurement, an attempt will be made to identify an off-site, background reference sampling location that has surface soils that are similar to the majority of the soils found on the Site. If sources of the soil fill can be clearly established such as any borrow areas on-site or specific uncontaminated areas of the Latty Avenue site, these sites may be proposed by the Respondents as additional reference background sampling sites for USEPA approval.

In evaluating site measurements against background measurements and identifying "hot spots", consideration will be given to any apparent differences in soil type at the various on-site measurement locations, and the typical range of gamma-ray exposure rate values reported for regional soils. With the preceding caveat in mind, those locations indicated in the overland radiological survey as having maximum exposure rates greater than twice background, will be designated as "hot spots". In the event that there are; an excessive number of "hot spots" identified under this criteria, or the indicated locations are not sufficiently distributed across the Site, or no "hot spots" are identified, then recommended alternate locations for borings will be submitted by the Respondent Group to USEPA for review and approval.

3.2.2 Equipment and Methodology

The overland gamma survey will be performed using a hand-held, portable sodium-iodide, thallium-activated (NaI [Tl]) gamma-ray survey instrument to determine radiation levels in units of counts per minute (cpm). This instrument is ideally suited for rapid measurement of low level environmental radiation; providing nearly instantaneous measurement results.

The NaI detector will be cross-calibrated with an integrating, pressurized ionization chamber (ion chamber) at least once a day within the area to be surveyed. This cross-calibration will permit the translation of the detector measurements in cpm to gamma exposure rates in units of micro-R per hour (μR/hr) in air. Cross-calibration measurements will be performed daily at up to three known "hot spots" by taking co-located NaI detector and ion chamber reading at one meter above the hot spot for a period of time sufficient to obtain a stable reading (3 to 5 minutes for the ion chamber). Such multiple point field calibrations are desirable since the NaI detector is much more energy dependent than the ion chamber. The derived conversion factor accounts for the differential energy of the gamma photons that penetrate the ground and those from the Cs-137 calibration source. Since the depth and isotopic distribution of the contamination (and therefore the energy of the penetrating photons) may vary across the site, a mean conversion factor is derived from measurements at several locations.

3.2.3 Surveying Grid Sampling Locations

All grid sampling points will be surveyed using a kinematic "stop and go" Global Positioning System (GPS) survey. With this type of survey, the grid sampling points can be located to an accuracy of greater than 0.1 feet in less than one minute. To achieve these results a minimum of four satellites are tracked at all times; additionally, two ground-based receivers must be placed at known positions. The coordinate positions of these two stations must be specified to within two inches.

Surveying is accomplished by a crewman with a backpack receiver and antenna. The antenna is placed on the ground at the location to be surveyed. The elevation and northing and easting coordinates of each point are then electronically recorded.

3.3 Soil Borings and Sample Analyses

The planned soil investigation will involve the drilling and soil sampling of 50 borings. Specific activities to be performed as part of the soil investigation include the following. Each of these activities are described below:

- Identify biased and unbiased soil boring locations
- Survey boring locations; both preliminary and final
- Conduct surface geophysical survey to identify drilling locations with minimal subsurface obstructions
- Collect and analyze landfill gas samples from each of the planned boring locations using a vapor probe
- Remove concrete and other surface debris from planned boring locations; construct access roads as necessary
- Decontaminate drilling and sampling equipment

- Drill and soil sample borings; collect contingency samples as appropriate
- Prepare detailed lithologic logs of each boring
- Perform downhole radiological logging of each boring
- Analyze soil samples
- Backfill borings and dispose of drill cuttings

3.3.1 Locations of Biased and Unbiased Soil Borings

A total of 50 soil borings are planned; 18 will be located within or about Area 1, and 32 within or about Area 2. Each boring is scheduled to be terminated within the underlying, undisturbed alluvium. Contingency soil borings may be performed if the findings from the overland radiological survey indicate widespread contamination, or if the soil analytical data from the planned soil sampling and analyses indicate that further characterization of the landfill is necessary. Eight of the planned soil borings will be completed as groundwater monitoring wells. The USEPA will be consulted prior to the drilling of contingency wells.

Based on review of aerial photographs, previous investigation findings, and the anticipated drilling of 5 "hot spot" borings, as identified from the planned overland survey, 24 of the planned borings will be biased sampling locations. The remaining 26 borings will be stratified random locations. Planned biased soil boring locations are shown on Figure 3-2. Grid cells for locating stratified random borings are shown on this figure also. Table 3-1 provides the coordinates, anticipated termination depths, and the rationale for the planned biased soil borings.

FIGURE 3-2

TABLE 3-1

TABLE 3-1 CONTINUED

The random borings will be placed within grid cells which do not contain a biased soil boring. Random boring coordinates will be determined using a random number generator. For the grid cells which are situated around the perimeter of Areas 1 and 2, random boring locations will be limited to the area defined by Areas 1 and 2 plus an additional 20 feet outward from the perimeter. Random sets of coordinates will be selected until a boring is located within this defined area. All soil boring locations, both biased and stratified random, will be reviewed and approved by the USEPA prior to drilling.

3.3.2 Surveying of Boring Locations

Each planned soil boring location will be surveyed twice. The initial survey will be to identify a location for performing the planned geophysical survey. This survey will delineate areas near the tentative boring location that have minimal subsurface ferromagnetic obstructions. The second survey will be conducted after the boring has been drilled and backfilled.

All surveying will be performed by a licensed surveyor and include ground surface elevation and northing and easting coordinates referenced to an existing on-site monument located at the northeast corner of the weigh station, along the St. Charles Rock Road entrance. Each location will be surveyed for elevation to an accuracy of 0.01 feet, and northing and easting coordinates to the nearest 0.1 feet.

3.3.3 Surface Geophysical Survey

Prior to the drilling of the soil borings, a surface geophysical survey (total magnetics) will be performed at each of the planned boring locations. The survey will encompass an area defined by a 15-foot radius circle from the identified boring location. The purpose of the survey is to define a location within this area with the least amount of potential ferromagnetic debris. This will be the location of the planned soil boring.

Concurrent with the geophysical survey will be a utility clearance to determine the potential presence of underground utilities at the planned boring locations. Boring locations will be relocated to adjust for the presence of underground and aboveground utilities if identified. An example of a utility clearance form is shown as Attachment 1.

After completion of the geophysical survey and utility clearance, a landfill gas sample will be collected at one or more depths at each boring location using a probe. This sample will be analyzed for methane concentration. The results of these analyses, together with previous landfill gas data collected by Laidlaw at the adjacent Bridgeton Sanitary Landfill, will be used to define appropriate health and safety procedures for the drilling program. The results of these analyses may also impact planned boring locations and precautionary measures to be implemented during the drilling. All planned soil borings and wells will be drilled and abandoned in accordance with applicable Missouri regulations.

3.3.4 Site Preparation

Prior to drilling, the ground surface in the immediate vicinity of each boring will be cleared of surface debris (concrete, rock, and other large materials). Clearing may also be required for drilling equipment access to some of the planned boring locations. Access restrictions may potentially impact placement of random boring locations. The USEPA will be notified and approval obtained prior to the change of any boring locations.

3.3.5 Drilling Equipment Decontamination

Prior to entering the Site, the drill rig will be cleaned and free of mud and other materials which may have adhered to the vehicle during drilling at off-site locations. All augers and sampling equipment will be steam-cleaned to remove oils, chemicals, soils and other debris and to prevent cross-contamination. Additional steam-cleaning will be performed on-site to prevent cross-contamination between borings. The steam-cleaning water will be containerized.

3.3.6 Drilling and Soil Sampling

Drilling of Soil Borings

Drilling and soil sampling will be accomplished using a large diameter, truck mounted auger. This type of drill rig is recommended because rock, concrete, and large metallic objects may be present in the landfill underlying Areas 1 and 2. The presence of these objects will limit the use of a small diameter hollow-stem auger, or other drilling equipment. Drilling will be initially performed using a 12-inch diameter auger bit. If obstructions are encountered, then the a larger bit will be used to advance the boring beyond the obstruction to the planned termination depth. The planned maximum bit size is 36-inch diameter.

With the large diameter auger, drilling is accomplished using a 3-foot to 7-foot long auger bit which is attached to a telescoping kelly. Borings are generally drilled un-cased. Soil cutting are removed from the boring on the auger bit and discharged onto the ground surface. The removed soil is generally representative of the bottom two to three feet of the boring. Soil materials from the boring are continuously, visually evaluated and can be monitored for VOCs using a Foxboro organic vapor analyzer (OVA), methane using a GasTech combustible gas indicator (lower explosive limit/oxygen meter [LEL/O_2], and radioactivity using a Geiger-Muller counter.

If methane concentrations above the lower explosive limit are detected during the drilling of a soil boring, then appropriate health and safety procedures will be implemented per the Site Safety and Health Plan.

Attachment 2 is an example of an instrument calibration log and Attachment 3 contains examples of various monitoring logs.

Collection of Soil Samples

Soil samples for potential laboratory analyses will be collected from each boring at 5-foot intervals, from the bottom of the large diameter auger drill bit. Each sample will be placed in an appropriate container and preserved as indicated in Table 4-1. For each sample retained for potential laboratory analysis, a second sample will be collected and temporarily placed in a disposable, resealable plastic bag. This second sample will be used to determine field VOC headspace concentrations, lower explosive limit (LEL), percent methane, oxygen, and carbon dioxide, and measurable radioactivity. Contingency soil sampling may occur at any depth in the boring. Please refer to Section 3.3.10 for a discussion on conditions which will trigger contingency soil sampling and the collection of perched water samples.

Duplicate soil samples will be collected from 10% of the total number of samples scheduled to be analyzed. Duplicate samples will be randomly selected prior to the start of the drilling program and collected in the same manner as the sample for which they are a duplicate. Split soil samples, for analysis by the USEPA, will be obtained if requested.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, depth of sample, analyses requested and the name of the sampler will be recorded on the label and in the

McLaren/Hart field log book with indelible ink. Each soil sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

3.3.7 Lithologic Logging of Soil Materials

A detailed lithologic log will be prepared during the drilling of each boring using Unified Soil Classification System nomenclature. Soil descriptions will include color, based on Munsell soil color charts; percent fines, sand, and gravel; field determined plastic characteristics of the fine fraction; grain size and grading of sand and gravel fraction; relative moisture content; and the presence of distinguishing features which may be indications of in-place or man-made deposits. In-place indications include: sedimentary structures such as bedding, vegetation and roots, blocky structure, etc. Man-made deposits can be expected to include: trashy debris and rubbish, concrete, brick, rock, especially limestone from the former quarry operations, wood and other construction materials, non-native vegetation, etc. Attachment 4 is an example of a soil boring log.

3.3.8 Downhole Radiological Logging

Downhole radiological logging is to be performed in each soil boring. The planned survey will be performed to determine the vertical distribution of radiological contaminants, and to identify soil samples for laboratory analysis. Downhole data from borings located along the perimeter of Areas 1 and 2 will additionally provide radiological data for assessment of background conditions. Logging will be performed using a 3/8"x3/8" sodium iodide (NaI) detector with a portable single channel analyzer (SCA) or multi-channel analyzer (MCA). The detector will be equipped with a collimeter to ensure that the photons detected originate from the nearest boring wall.

Testing is performed through 2-inch diameter PVC casing which is temporarily placed and positioned along the northern-most sidewall of each boring. The NaI detector is attached to a cable and initially lowered to the bottom of the casing. The instrument is then withdrawn and measurements recorded at one foot increments starting at the bottom. The scaler to be used is a Ludlum Measurements Inc. Model 2200 or Model 2350 which can be operated in either the scaler or count rate mode. These devices are hand-held units that can be operated using an internal battery supply. The operating procedures for these units (which will be provided to

EPA prior to the initiation of field work) are described in the manufacturer's operating manuals[1]. The analyzer will be set up with an energy threshold of approximately 100 keV and an open energy window. The detector is calibrated semi-annually with a Cs-137 source to verify the relationship between cpm and exposure rate (about 30 cpm/uR/hr). Calibration of the detector is performed at a licensed calibration facility.

Down-hole gamma logging using the NaI detector is currently scheduled to be used only to identify the vertical extent of radioactive contamination beneath Areas 1 and 2. However, the NaI detector can additionally be used in the field to infer the speciated concentration of many of the radionuclides of interest based on information obtained by radionuclide analysis of a number of representative samples. Gamma spectroscopy using a germanium detector can be used in the field to directly determine the speciated concentration of the radionuclides. The only radionuclide that cannot be quantified in the field by gamma spectrometry is Th-230, which is not a gamma emitter.

Use of direct reading instruments for field quantification of radionuclides will be explored as part of the planned field activities. If a constant relationship between the concentration of the various radionuclides present at the site can be demonstrated in a number of the initial soil borings using radiochemical analysis, then it will be proposed that these analyses be performed in the field and that the number of radiological soil samples analyzed in the laboratory be reduced. USEPA approval will be sought and obtained prior to any changes in analytical methods.

3.3.9 Analysis of Soil Samples

Selection of Soil Samples for Laboratory Analysis

The overland radiological survey will provide the basis for selecting 5 "hot spot" boring locations, and the downhole radiological survey will provide the basis for selecting soil samples for laboratory analyses of radionuclides. Two samples from each of the 50 planned soil borings will be analyzed for the four primary radionuclides (uranium-235 and 238, thorium-230, and radium-226). One sample from each of the 5 "hot-spot" boring locations will additionally be

[1] Ludlum Measurements, Inc., Sweetwater, Texas. Operating Manual for the Ludlum Model 2200 Single Channel Analyzer; Operating Manual for the Ludlum Model 2350 Data Logger.

analyzed for the additional radionuclides of interest (uranium-234, protactinium-231, actinium-227, lead-210, and thorium-232). When identifying "hot-spot" sample locations, consideration will be given to both the numerical value of the reading, the areal extent over which the "hot-spot" was identified, and the geographic distribution of "hot-spots" on the Site. The USEPA will be consulted in assessing "hot-spot" sampling locations.

One soil sample from each boring will correspond to the soil sample collected at/near the radiological high, as determined by the downhole survey. The second sample will be collected immediately below the base of the radiologically elevated interval, or the base of the landfill debris, if elevated readings are not detected in the boring.

Selected soil samples from Areas 1 and 2 will also be analyzed for the non-radiological chemicals of concern (VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). One soil sample from 18 of the 50 planned borings will be analyzed for these compounds. The soil borings selected for analysis include the six biased borings identified based on review of aerial photographs, and 12 selected borings located within the interior of Areas 1 and 2. The 18 borings to be sampled will be evenly distributed throughout these areas to allow adequate assessment of the landfill.

Soil samples for non-radiological chemicals of concern will be collected from the lower portion of the landfill debris, and generally at the same depth as the lower radiological sample in the selected boring. The location of the 18 borings selected for analysis of non-radiological chemicals of concern will be subject to approval by the USEPA prior to the start of the drilling program.

Laboratory Analyses

Radiological samples will be analyzed by one or more of the following methods:

Uranium-234, 235, and 238	NAS-NA-3050
Thorium-230	NAS-NS-3004
Thorium-232	NAS-NS-3004
Radium-226	HASL 300
Protactinium-231	HASL 300
Actinium-227	HASL 300
Lead-210	HASL 300

Non-radiological samples will be analyzed for one or more of the following methods:

Volatile organic compounds (VOCs)	EPA Method 8240
Semi-volatile organic compounds (SVOCs)	EPA Method 8270
Pesticides/PCBs	EPA Method 8080
Priority pollutant metals	EPA Method 6010/7000
Cyanide	EPA Method 9010
Total petroleum hydrocarbons	EPA Method 8015M

Duplicate soil samples will be analyzed for the same constituents as the sample they were obtained from.

The laboratory(s) for analysis of radiological and non-radiological chemicals of concern has not been selected at this time. Standard operating procedures for the selected laboratory(s) will be forwarded to the USEPA for review and approval prior to the start of the field investigation. Laboratory analyses will be performed at "Analytic Level III" for both radiological and non-radiological chemicals of concern.

3.3.10 Contingency Sampling and Analyses

If during the drilling of a boring, groundwater seepage is encountered within the landfill deposits, or at the base of the landfill, then drilling will temporarily stop and an attempt will be made to obtain a water sample using a hydropunch sampler. If attempts are unsuccessful, then a representative sample of the saturated soil will be collected, and retained for laboratory analyses. Laboratory geotechnical testing of clayey fine grained soils beneath perched water may be tested for permeability if the thickness of this clayey unit is 5 feet or greater. Permeability testing is the preferred test method; however, if the soil samples are disturbed and unsuitable for testing, then the permeability will be estimated based on grain size analysis and a hydrometer test.

Contingency soil sampling will occur primarily in response to encountering perched water as indicated above, or observations during drilling which suggest the possible presence of an unknown hazardous chemical compound. Drilling observations which may trigger contingency soil sampling and analyses will be based on visual observations (presence of dark or light color semi-solids, oily film on soil, multi-colored soil, crystalline structure, leaking drums, etc.), olfactory indications, or field monitoring data (e.g. significant change [10x] in OVA readings compared to other measurements in the boring).

Contingency samples will be generally analyzed for the complete suite of non-radionuclide chemicals of concern (VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide); however, conditions that trigger the collection of a sample may also be used as a basis for limiting the number of analyses to be performed. The USEPA will be consulted and confirmation will be obtained prior to reducing the types of analyses to be performed on the contingency samples.

Contingency sampling will trigger the collection and analysis of a second soil sample from that boring. This sample will be collected to confirm the vertical extent of possible contaminants and will be collected at the base of the landfill, or within the underlying alluvium at a depth which is expected to be below possible soil contamination. This sample will be analyzed for only those compounds which are detected above the established background concentrations in the contingency sample. Contingency soil samples will be analyzed on a rush basis to ensure that they are analyzed within the proper holding times.

3.3.11 Backfilling of Boring and Disposition of Drill Cuttings

Soil cutting from the drilling of the borings will be placed on heavy duty plastic sheeting within 10 feet of the boring. If during the drilling of the borings, visual observations (presence of dark or light color semi-solids, oily film on soil, multi-colored soil, crystalline structure, leaking drums, etc.), olfactory indications, or field monitoring data (e.g. significant change [10x] in OVA readings compared to other measurements in the boring) suggest the possible presence of hazardous chemical compounds, then efforts will be made to segregate the soil into separate piles. Efforts to segregate the radiologically impacted soil will occur also, if possible. All soil piles will be covered with plastic sheeting, and sandbags will be placed on the plastic sheeting to secure the plastic. The soil piles will be inspected on a routine monthly basis to ensure that they are properly covered and not a potential source of fugitive dust. After the field investigation is complete and the character of the soil piles is known, then recommendations for long-term management of the soil piles will be provided.

All borings will be backfilled with cement slurry using a tremie pipe placed at the bottom of the boring. All borings will be backfilled in accordance with the state of Missouri regulations.

Disposal of soil cuttings will be based on the results of soil samples collected and analyzed from each boring, visual observations, and monitoring data. A plan for disposal of the drill cuttings will be developed and submitted to the USEPA for review within 60 days of completion of the soil borings. This plan may include additional laboratory analyses to characterize the soil piles.

3.4 Groundwater Monitoring Well Construction, Elevation Monitoring, and Sampling

The planned groundwater investigation will involve the drilling and construction of 18 monitoring wells; contingencies for the construction of additional monitoring wells are also included. Specific activities to be performed as part of the groundwater investigation include the following. Each of these activities are described below:

- Evaluate planned well locations; re-locate as necessary based on current groundwater flow data and results of overland radiological survey and soil sampling analytical data
- Remove concrete and other surface debris from planned well locations; conduct surface geophysical survey; construct access roads as necessary
- Decontaminate drilling and sampling equipment
- Pre-drill with a large diameter auger to undisturbed natural alluvium at each planned monitoring well locations; backfill boring to grade, as appropriate
- Drill, lithologically log boring, and construct monitoring wells
- Develop newly constructed and selected existing monitoring wells
- Survey locations and elevations of newly constructed and existing monitoring wells
- Conduct groundwater elevation monitoring
- Perform groundwater sampling and analyses
- Conduct aquifer testing

3.4.1 Locations

Eighteen groundwater wells are scheduled to be placed around the perimeter of Areas 1 and 2. Some of the currently planned well locations may change based on the results of the overland gamma survey, soil analytical data from the planned perimeter borings, and confirmation of groundwater flow direction. All monitoring wells will be screened within the alluvium and completed as shallow, intermediate depth, and deep wells. The wells will be constructed generally similar to the existing on-site wells. All monitoring well locations will be submitted for approval to the USEPA prior to drilling and construction.

No bedrock wells are planned at this time; if required for chemical characterization, they will be completed as contingency wells. Contingency wells have also been identified for the interior of Areas 1 and 2, if required to confirm groundwater flow direction. Contingency monitoring well construction may also occur if selected existing monitoring wells near Areas 1 and 2 are damaged and non-usable for monitoring and sampling purposes.

Monitoring well locations planned for each of the three depth intervals are shown on Figures 3-3, 3-4, and 3-5. Included also on these figures are the locations of existing monitoring wells completed at similar depth intervals which can potentially be used for groundwater monitoring and sampling. Locations of planned staff gages in the surface water body located north of Area 2 are also shown on these figures.

3.4.2 Site Preparation

Prior to drilling, the ground surface in the immediate vicinity of each well will be cleared of surface debris (concrete, rock, and other large materials), and a surface geophysical survey (total magnetics) performed to delineate subsurface ferromagnetic obstructions. Clearing may also be required for drilling equipment access to some of the planned boring locations. Access restrictions may potentially impact placement of some monitoring wells. The USEPA will be notified and approval obtained prior to the change of any boring locations.

FIGURE 3-3

FIGURE 3-4

FIGURE 3-5

3.4.3 Drilling Equipment Decontamination

Prior to entering the Site, the drill rig will be cleaned and free of mud and other materials which may have adhered to the vehicle during drilling at off-site locations. All augers and sampling equipment will be steam-cleaned to remove oils, chemicals, soils and other debris and to prevent cross-contamination. Additional steam-cleaning will be performed on-site to prevent cross-contamination between borings. The steam-cleaning water will be containerized.

3.4.4 Pre-Drilling of Monitoring Wells

Each of the planned monitoring well locations will be pre-drilled to the base of the landfill using a large diameter auger. Pre-drilling will remove landfill debris which may potentially interfere with the well construction activities. The pre-drilled borings will be backfilled with a cement slurry using a tremie placed at the bottom of the boring, prior to well drilling. An exception will occur if groundwater is encountered within the landfill, or anticipated to be within 5 feet of the base of the landfill. In these instances, the large diameter auger boring will be drilled to a depth of 10 feet below the depth that water was encountered, and a shallow monitoring well will be constructed in the large diameter boring.

Some of the pre-drilling locations will correspond to the planned soil borings, and others, specifically those located in areas where multiple wells are to be constructed (cluster wells), will be drilled after completion of the soil borings. All wells will be constructed within separate, backfilled large diameter borings which are terminated in the underlying alluvium. No multiple completion wells are planned.

At locations where multiple wells are to be constructed, each well cluster boring will be located at a minimum distance of 10 feet from the closest adjacent boring. This will minimize the effects of potential caving which may occur during the drilling, and reduce the likelihood that placement of the well sanitary seal will adversely impact the aquifer materials in the adjacent well.

Soil sampling for laboratory analyses is not scheduled to occur during the drilling of the pre-borings, except in those borings which have been previously identified for soil sampling and analyses. Soil cuttings, however, will be visually evaluated and monitored using an OVA, LEL/O_2 meter, and a Geiger-Muller counter, and a detailed lithologic log of the boring prepared. If visual observations, olfactory evidence, or monitoring data suggest the possible presence of hazardous compounds, as previously described, then contingency soil sampling and analyses may be performed. Soil samples of all suspect materials will be retained and a decision to analyze these samples will be reached after all cluster well borings at a specific location have been drilled.

Each pre-boring will be downhole radiologically logged. Downhole radiological data from these borings can potentially be used to verify and establish background conditions, and to evaluate variability in radiological readings in the landfill from several closely spaced borings.

3.4.5 Drilling and Construction of Monitoring Wells

Drilling and Collection of Lithologic Samples

All of the planned alluvial monitoring wells will be drilled using 10 to 12-inch diameter (O.D.) hollow-stem augers. Soil samples will be collected during the drilling of the wells for lithologic purposes using a split-spoon drive sampler. Samples will be collected at 5-foot intervals to the planned termination depth, starting at a depth of five feet below the bottom of the pre-drilled boring. The planned termination depth for the shallow wells is 10 feet below the top of the groundwater surface, as indicated by saturated soil conditions in the retrieved soil samples; while, the termination depth for the deep alluvial wells is the bedrock contact. The intermediate depth wells will be terminated at a depth which is equivalent to the average depth of the shallow and the deep wells.

For the cluster monitoring wells, only the deepest boring will be soil sampled. The planned termination depths and monitoring well design for the adjacent wells will be based on this boring. Tentative termination depths for the planned monitoring wells are presented in Table 3-2.

Monitoring Well Design and Construction

Each monitoring well will be constructed with 4-inch diameter, threaded schedule 40 PVC pipe and slotted well screen, unless soil samples from the pre-drilled boring indicate groundwater may be potentially impacted by halogenated VOCs at concentrations which may damage the well

TABLE 3-2

screen. If this situation occurs, then the wells will be constructed of 4-inch diameter low carbon steel with a stainless steel well screen.

All well screen and pipe will be steam cleaned and measured prior to construction of the well. The shallow wells will be constructed with a three foot cellar, 20 feet of well screen (placed 10 feet above and 10 feet below the groundwater surface), and solid pipe which extends approximately two feet above the ground surface. The intermediate and deep wells will be constructed similarly; however, the well screen will be 10 feet long. The well screen slot size and filter pack for all wells will be determined after performing a sieve analysis of the soil samples collected from the planned screen interval. Testing will be performed in the field, and the driller will have available a variety of well screen sizes (0.010, 0.020, and 0.030 inch), and appropriate sand pack materials for use with these screens.

Construction of the monitoring wells will be through the hollow-stem augers. Filter pack materials will extend approximately two feet above the top of the well screen, and a two foot bridge of hydrated bentonite will be placed above the filter pack. Neat cement grout will extend from the bridge to the ground surface.

Steel protective casing with a 2 to 3 foot stickup will be driven in-place over the top of the casing. The casing will be covered with a cap, and the protective casing with a locking cover. A concrete pad (3 feet by 3 feet) will be constructed around the base of the protective casing. The concrete pad and adjacent ground surface will be sloped to direct surface water away from the well and minimize potential ponding of rainwater near the well.

3.4.6 Development of Newly Constructed and Selected Existing Monitoring Wells

All newly constructed wells will be developed using surge block, bailing, and pumping techniques. A minimum of 10 casing volumes of water will be removed during well development. During development, physical parameters, pH, electrical conductivity, temperature, and turbidity, will be monitored. Development will continue until these physical parameters have stabilized and the water is non-turbid (<30 Nephelometric Turbidity Units [NTUs], unless this turbidity level is not achievable, based on field measurements, and an agreed change is approved by the USEPA). Stabilization is achieved when pH is constant and to within 0.1 pH unit, conductivity does not vary by more than 10 percent from the previous reading, and the temperature does not vary by more than 1 degree centigrade. Development water will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

Existing wells suitable for use as groundwater elevation monitoring wells, and possibly for the collection of groundwater samples and analyses, will be re-developed to remove sediment that may have accumulated in the bottom of the well, and to ensure that the purged water is non-turbid. A minimum of 10 casing volumes of water will be removed during well development. Development water will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

Attachment 5 is an example of a well development log.

3.4.7 Surveying of Well Locations

All newly constructed and existing monitoring wells will be surveyed for elevation to an accuracy of 0.01 feet, and northing and easting coordinates to the nearest 0.1 feet. Surveying of monitoring wells will include the elevation of the ground surface, top of casing (north side of casing), and the top of the protective casing.

All surveying will be performed by a licensed surveyor and include ground surface elevation and northing and easting coordinates referenced to an existing on-site monument located at the northeast corner of the weigh station, along the St. Charles Rock Road entrance.

3.4.8 Groundwater Elevation Monitoring

All wells, newly constructed and existing, along with staff gages which have been placed in the pond north of Area 2, or elsewhere on the West Lake property, will be monitored on a monthly basis using an electronic water sounding device to an accuracy of 0.01 feet. Water elevation data collected prior to the construction of new wells will confirm groundwater flow direction. Elevation data collected on multiple dates will be useful for assessing changes in groundwater elevation and flow direction which may occur seasonally, or in response to a rainfall event.

During the initial sounding of each well, an oil/water interface probe will be used to determine whether free-phase hydrocarbons are present in groundwater.

3.4.9 Groundwater Sampling and Analyses

Wells Scheduled to be Sampled and Sampling Frequency

Two rounds of water quality sampling are planned for the newly constructed and selected existing wells. Existing monitoring wells tentatively scheduled for sampling are identified below. The wells selected may change based on the condition of the wells, as determined during the initial assessment of each well, or groundwater elevation data collected after construction of the new groundwater wells.

Shallow Wells: S-60, S-61, S-84, MW-101, and MW-106

Intermediate Depth Wells: I-62, I-65, I-66, I-67, and I-68

Deep Wells: D-83, D-85, D-93, and D-94

Sampling of all wells will be performed within a three to five day period. The initial sampling round will occur approximately two weeks after well completion and development. The second sampling round will occur six to eight weeks after the initial sampling.

Prior to the second sampling round, water quality analytical data from the newly constructed and existing wells will be evaluated. Based on this evaluation, a change in the number and location of existing wells to be sampled may occur. USEPA approval will be obtained, prior to any changes in the existing wells to be sampled. All newly constructed wells will be sampled during this second sampling round.

Equipment Decontamination

Prior to the start of a sampling round, all equipment to be used during the purging of the well and sample collection is cleaned in the shop. To clean the sampling equipment, the sample catcher, packer, check valves, inlet foot, and sample toggle valve are placed in a cleaning solution of non-phosphate detergent and water. Components are allowed to soak for approximately five minutes, brushed inside and out, and removed from the solution. They are rinsed repeatedly with tap water or distilled water and placed in racks to air dry. The equipment is then placed into clean plastic bags to avoid contact with contaminants.

Purging of Well Prior to Sample Collection

Prior to the collection of the samples, each well will be purged to remove a minimum of three casing volumes. Physical parameters (pH, temperature, electrical conductivity, and turbidity) will be monitored during well purging. If field parameters have not stabilized after the removal of three casing volumes, then additional water will be removed until stabilization is achieved. Stabilization is achieved when pH is constant and to within 0.1 pH unit, conductivity does not vary by more than 10 percent from the previous reading, and the temperature does not vary by more than 1 degree centigrade.

Purging of the wells will be accomplished using one of the following:

- Submersible pump
- Centrifugal pump (depth dependent)
- Bailer

If a well is low yielding, it will be pumped to dryness and allowed to recharge to within 80 percent of the original water level prior to sampling. The groundwater sample will be collected within 24 hours regardless of whether or not the well has recharged to within 80 percent of the original water level. The volume required to pump the well dry will be calculated and recorded in the field log book.

Water generated during the purging of the wells will be containerized at each well location and covered. Treatment and disposal of the purged water will be based on water analytical results from sampling of each well.

Groundwater Sample Collection

Groundwater samples will be collected using either stainless steel bailers or a disposable polyethylene bailers. After the sample is collected, it is discharged into appropriate laboratory sampling glassware using a sample port that is inserted in the bottom of the bailer. Each sample will be placed in an appropriate container and preserved as indicated in Table 4-1.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

Plastic sheeting will be placed on the ground near the well prior to sampling to prevent soil particles from adhering to the rope and entering the well. The rope attached to the bailer will be disposed following the sampling of each well to minimize the potential for cross contamination. If a stainless bailer is used, then the bailer and sampling port will be properly cleaned between the sampling of each well, following the procedures identified above.

Filtered samples will be obtained using a pressurized bailer and a 0.45 micron disposable filter.

QA/QC Samples

QA/QC samples (trip blanks, field blanks, and duplicates) will be collected and analyzed during each sampling round.

- Trip blanks will be placed in each shipment container and analyzed for one of the radionuclides of concern (Uranium 234, 235, 238 and Radium 226) and VOCs. The number of trip blanks will be dependent on the number of containers shipped to the laboratory.

- Field blanks (rinse blanks) will be collected on a daily basis from one randomly selected well and will be analyzed for one of the radionuclides of concern (Uranium 234, 235, 238 and Radium 226) and VOCs. If sampling is performed over a five day period, then five field blanks will be collected and analyzed.

- Duplicate samples (randomly selected) will be collected and analyzed from at least 10% of the total number of wells sampled. Thirty-two wells are scheduled to be sampled, therefore two duplicates will be collected and analyzed. Duplicates will be analyzed for all of the chemicals of concern.

Laboratory Analyses

Groundwater samples from all wells will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). In addition, the sample collected from MW-106 will be analyzed for thorium-232 to verify the results of previous analyses from this well. Priority pollutant metals and radionuclide analyses will be performed on both filtered and unfiltered samples during the initial sampling round, and unfiltered samples during the second sampling round. Filtered analyses may also be performed on selected wells for selected metals during the second sampling round.

Radiological samples will be analyzed by one or more of the following methods:

Uranium-234, 235, and 238	NAS-NA-3050
Thorium-230	NAS-NS-3004
Thorium-232	NAS-NS-3004
Radium-226	EPA Method 903.0
Protactinium-231	EPA Method 901.0
Actinium-227	EPA Method 901.0
Lead-210	EPA Method 901.0

Non-radiological samples will be analyzed for one or more of the following methods:

Volatile organic compounds (VOCs)	EPA Method 624
Semi-volatile organic compounds (SVOCs)	EPA Method 625
Pesticides/PCBs	EPA Method 8080
Priority pollutant metals	EPA Method 200 Series
Cyanide	EPA Method 335.2
Total petroleum hydrocarbons	EPA Method 8015M

The laboratory(s) for analysis of radiological and non-radiological chemicals of concern has not been selected at this time. Standard operating procedures for the selected laboratory(s) will be forwarded to the USEPA for review and approval prior to the start of the field investigation. Laboratory analyses will be performed at "Analytic Level III" for both radiological and non-radiological chemicals of concern.

3.4.10 Aquifer Testing

Aquifer testing will consist of performing slug tests on all newly constructed wells. Slug tests provide a rapid, cost effective means of determining the hydraulic conductivity of aquifer materials in the immediate vicinity of the well boring. An appropriately sized slug will be used to perform the slug tests. The diameter and length of the slug will be sufficient to create a minimum of 2 to 3 feet elevation change in groundwater level. During the test, monitoring of both rising head and falling head conditions will be performed using a pressure transducer. Attachment 6 is an example of a slug test log. As a contingency, aquifer testing by a pump test may be considered if water quality data from the wells indicate the need to additional testing. All aquifer testing equipment will be decontaminated prior to placement in the monitoring wells.

3.5 Surface Soil Cover Sampling and Analyses

3.5.1 Surface Sample Locations

Surface soil samples of the landfill cover will be collected at 15 locations; 5 radiological "hot-spots", and 10 at selected soil boring locations. Additional samples will be collected at any location where surface indications suggest the presence of potential contamination.

The 5 radiological "hot-spot" surface samples will be collected in conjunction with the drilling of the 5 radiological "hot-spot" borings, and will be collected at the same locations. The 10 additional sampling locations will be randomly selected from the soil boring locations which were selected by stratified random sampling; 3 borings will be selected from Area 1, and 7 from Area 2. Additional, non-radiological samples will be collected in any areas in which surface or olfactory indications, or monitoring data (OVA and LEL/O_2) suggest the potential presence of hazardous chemicals. Surface visual indications include: staining, multi-colored soil, an unexplained damp or wet area, distressed vegetation, evaporite chemical precipitate or crust on soil, etc.

In the event that 5 radiological "hot spots" are not identified, then the remaining surface samples will be collected from randomly selected soil borings which were located by the stratified random process. All surface sampling locations will be submitted to the USEPA for review and approval, prior to the collection of any samples.

3.5.2 Sample Collection

Surface sampling of the landfill cover will be performed by collecting a soil sample from the upper 2 inches of the soil cover in conjunction with the drilling of the soil borings. Samples for analysis of VOCs will be performed at a depth of 18 inches to 24 inches. The planned air sampling of the landfill surface for volatile chemicals of concern using a flux chamber may eliminate the need to collect soil samples for VOC analysis. The decision to sample both the soil and surface of the landfill for VOCs will be based on consultation with the USEPA and the Missouri Department of Health (risk assessment contractor). Each sample will be placed in an appropriate container and preserved as indicated in Table 4-1.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, depth of sample, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each soil sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

3.5.3 Laboratory Analyses

All surface soil samples will be analyzed for all chemicals of concern: the four primary radionuclides (uranium 235 and 238, thorium 230, and radium 226), VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide. Analyses will be performed using the same methods as those identified for the soil boring samples (see Section 3.3.9).

In addition to the laboratory chemical analyses, all surface soil samples will be analyzed for the following geotechnical parameters: moisture, density, and percent relative compaction.

3.6 Leachate Sampling and Analyses

3.6.1 Sampling Locations and Sampling Method

The slope faces (berms) that bound Areas 1 and 2 will be examined for the presence of seeps on a weekly basis during the time the field investigation is occurring. All seeps that are identified will be sampled. If the volume of seepage is inadequate for the collection of a surface discharge sample, then sampling will include the installation of one or more lysimeters at each seep location. Each sample will be placed in an appropriate container and preserved as indicated in Table 4-1.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

3.6.2 Laboratory Analyses

Leachate samples will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). Metal analyses will be performed on unfiltered samples, and also filtered samples if a sufficient quantity of liquid is obtained. In addition to the above analyses, leachate samples will be analyzed for biological oxygen demand, chemical oxygen demand, pH, total dissolved solids, total organic carbon, chlorides, nitrite, nitrate, ammonia, total phosphorous, and sulfide.

If a sufficient quantity of liquid cannot be obtained, then a sample of the saturated soil will be analyzed for those chemicals of concern and parameters which could not be analyzed from the liquid sample. Chemical analyses of liquid samples will be prioritized based on the quantity of liquid available for testing, the analytical requirements, and the analytes which may have been detected in soil borings drilled through the landfill.

Analysis of liquid samples will be performed using the same methods as those identified for the monitoring well samples (see Section 3.4.8). Analysis of soil samples will be performed using the same methods as those identified for the soil boring samples (see Section 3.3.9).

Leachate indicator parameters will be performed by the following methods:

Biological oxygen demand (BOD)	EPA Method 405.1
Chemical oxygen demand (COD)	EPA Method 410.4
pH	EPA Method 150.1
Total dissolved solids (TDS)	EPA Method 160.1
Total organic carbon (TOC)	EPA Method 415.1
Chlorides	EPA Method 325.2
Nitrite	EPA Method 300.0
Nitrate	EPA Method 353.1
Ammonia	EPA Method 350.1
Total phosphorous	EPA Method 365.1
Sulfide	EPA Method 376.1

3.7 Rainwater Run-Off and Erosional Sediment Sampling and Analyses

3.7.1 Sampling Locations

A map showing the locations of planned rainwater run-off and erosional sediment samples is presented as Figure 3-6. These sampling locations are based on drainage patterns as determined from the site topographic map and will be confirmed during the site surveillance. If the site reconnaissance indicates additional locations where rainwater accumulates and flows off-site, then these additional areas will also be considered for possible sampling and analysis. All sampling locations will be confirmed with the USEPA prior to the collection of samples.

3.7.2 Sample Collection

Rainwater run-off samples will be collected within 24-hours of a rainfall event which produces, or is anticipated based on weather forecasts to produce, greater than 1-inch of rainfall at nearby Lambert Field airport, and generates a sufficient quantity of run-off for collection of samples. At the planned sampling locations, flow will be directed through a calibrated "V-notch" weir, or a pipe to estimate flow volume at the time of sampling. Water samples will be collected on the upstream side of the weir, or from the pipe using appropriate sampling containers and preserved as indicated in Table 4-1. Temperature, pH, and specific conductance, hardness and dissolved oxygen will be measured directly in the field at each sampling location or in a separate beaker, as necessary.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

After collection of the rainwater run-off samples, the weirs will be removed. Sediment samples will be collected within 24-hours after the rainfall event at the location where the "V-notch"

FIGURE 3-6

weir, or pipe was previously located. Sample collection and handling will be performed consistent with the procedures outlined in section 4 of the SAP.

3.7.3 Laboratory Analyses

Rainwater run-off samples will be analyzed for the complete suite of chemicals of concern, except priority pollutant metals (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, and cyanide). Radionuclide metal analyses will be performed on both unfiltered and filtered samples. Priority pollutant metal analyses are not being performed on rainwater runoff samples because erosional sediments are to collected at the same location, and the sediment samples will provide a better indication of whether or not metals are being transported offsite by rainwater run-off.

Erosional sediment samples will include all of the chemicals of concern, except the VOCs (uranium-235 and 238, thorium-230, radium-226, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide).

Analysis of rainwater samples will be performed using the same methods as those identified for the monitoring well samples (see Section 3.4.8). Analysis of sediment samples will be performed using the same methods as those identified for the soil boring samples (see Section 3.3.9).

3.8 Surface Water Sampling and Analyses

3.8.1 Sample Locations

Surface water samples will be collected from the surface water body located immediately north of Area 2, and any other low-lying water drainage retention area receiving rainwater run-off from Areas 1 and 2, or any leachate from these areas (see Figure 3-3). Surface water sampling will be performed approximately three days after the end of a precipitation event in which an accumulation of greater than one inch is recorded at nearby Lambert Field airport. Sampling after a significant rainfall event will ensure that the majority of the water contained in these surface water bodies originates from the Site and is representative of surface run-off.

Staff gages will be located at all planned sampling locations. The staff gages will be surveyed for elevation and northing and easting coordinates and monitored on a monthly basis in conjunction with the groundwater monitoring program.

3.8.2 Sample Collection

Surface water samples will be collected from the surface water body located immediately north of Area 2, and any other low-lying water drainage retention area receiving rainwater run-off from Areas 1 and 2, or any leachate from these areas. Surface water samples will be grab samples collected in appropriate laboratory cleaned containers and preserved as indicated in Table 4-1.

Two samples from the surface water body north of Area 2 will be collected; one on the upstream side of the culvert located beneath St. Charles Rock Road, and the other at the furthest upstream location receiving run-off or potential leachate from the Site. These sampling locations correspond to the locations of planned staff gages.

Surface water samples at each sampling location will be collected from mid-depth at a midstream location, to minimize the effects of surface aeration and bank turbulence. Sampling will begin with the most downstream sampling point and will proceed in an upstream direction. The samples will always be collected upstream from the sampler's position. The sample location and depth will be recorded in the field log book. As well as the water level elevation as indicated by the staff gage located at the sampling station.

Temperature, pH, and specific conductance, hardness and dissolved oxygen will be measured in the field at each surface water location either directly from the water body or in a separate beaker, as necessary. The samples will be collected by immersing either the sample container, or a clean stainless steel or glass beaker into the water. As noted, the water will be transferred from the beaker into the appropriate sample container in a manner that minimizes aeration.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each sample collected will be recorded on a chain-of-custody record. Please refer to Section 4.0 for additional discussion on sample handling procedures.

3.8.3 Laboratory Analyses

All surface water samples will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals, and cyanide). Priority pollutant metal and radionuclide analyses will be performed on both filtered and unfiltered samples. Analysis of samples will be performed using the same methods as those identified for the monitoring well samples (see Section 3.4.8).

3.9 Geotechnical Evaluation of Area 2 Landfill Slopes (Berms)

A geotechnical investigation will be conducted to evaluate the stability of the slope (berm) on the north side of Area 2. Field work to be performed as part of this evaluation will include: collection of a minimum of four soil samples using a hand-held sampler from the face of the slope, and also from one boring drilled at the top of the landfill using a large diameter drilling rig equipped with a drive sampler (one of the planned biased soil borings can be used for this purpose); field mapping to profile the slope at several locations; and visual evaluation of any portions of the slope that have been exposed due to sloughing or erosional scour. Groundwater data from a nearby well will also be obtained to determine seasonal variations in depth to water beneath the slope.

Soil samples will be geotechnically analyzed for moisture/density, and direct shear tests will be performed to determine strength characteristics of the soil cover and the soils contained within the landfill. Building materials and miscellaneous debris present within the landfill may prevent the collection of relatively undisturbed soil samples; therefore, the samples may need to be sieved in the laboratory and remolded to field conditions prior to testing.

Geotechnical testings will also include a shear test and a consolidation test on an undisturbed soil sample of the alluvium from beneath the landfill. If obstructions within the landfill prevent drilling to the desired depth, then an undisturbed sample will be collected outward from the toe of the slope using a hand-auger and drive sampler and the sample retained in a brass rings for testing.

3.10 Radon Sampling and Analysis

3.10.1 Sample Locations

Radon flux measurements will be collected during two rounds of sampling at five locations in Areas 1 and 2. Samples will be taken at one radiological "hot spot" in each of these areas; the three remaining locations will be randomly selected, one in Area 1 and two in Area 2. If no "hot spots" are identified, then all five samples will be randomly located.

The radon sampling rounds will be separated by as much time as practical to permit sampling under different meteorologic conditions. The initial sampling will be performed prior to mobilization of drilling equipment to the Site to acquire health and safety data.

3.10.2 Sample Collection and Laboratory Analysis

Sampling will be performed using charcoal-based radon canisters suspended in an inverted container such as a plastic bowl or bucket. The approach will be to trap radon emanating from the ground and collect essentially 100% of the radon with the charcoal canister.

Each canister/container assembly will be left in place for 2 days. The canisters will then be sent off-site for laboratory analysis. The activity of radon based on the gamma measurements is then converted to radon flux (pCi/m^2-sec) by dividing the activity by the area of the collector (m^2), the amount of time the canister was left in place, and a decay correction factor.

A unique sample identification number will be assigned to each sample container and a label will be affixed to each container. The sample identification number, location, time, date, analyses requested and the name of the sampler will be recorded on the label and in the McLaren/Hart field log book with indelible ink. Each sample collected will be recorded on a chain-of-custody record.

3.11 Landfill Gas Sampling and Analysis

Landfill gasses will be evaluated for site characterization, risk assessment, and also for health and safety purposes during the remedial investigation. With regards to site characterization and risk assessment, three potential air contaminant concerns have been identified at the Site. The first concern is the generation of radon from the decay of radioactive waste, the second is the potential presence of landfill gas and other non-radiological volatile chemicals of concern, and the third is fugitive dust.

3.11.1 Radon Flux Measurement

Radon flux measurements will be taken in both Areas 1 and 2 of the site. Flux measurements will be taken at identified radioactive "hot spots" and at other locations that are randomly selected. Samples will be collected using commercially available, charcoal-based radon canisters suspended in an inverted container such as a plastic bowl or bucket. Each canister/container assembly will be left in place for 2 days to determine average radon flux levels at the Site. Two rounds of sampling will be conducted, with the intent of having the sampling rounds separated by a significant amount of time so that radon flux under two different sets of meteorologic conditions can be established.

3.11.2 Non-Radiological Landfill Gas Monitoring

As part of efforts to characterize the nature and extent of non-radioactive contamination in Areas 1 and 2, a landfill gas sample will be collected at each planned boring and well location using a probe (methane analyses only). Eight additional air samples will be collected from the surface of the landfill using a flux chamber. These additional samples will be analyzed for volatile organic chemicals of concern.

Vapor Probe Sampling and Analysis of Landfill Gas

Landfill vapor samples will be collected at two depths at each of the planned soil boring/monitoring well locations. Samples will be collected at 5 feet and 10 feet below ground surface using a vapor probe which is pushed to the desired depth using a percussion hammer, or hydraulic press. Once the probe has been pushed to the sampling depth the probe is retracted 6-inches to 12-inches.

Soil gas samples will be collected in tedlar bags using a vacuum pump. Initially, site specific probe purging and sample volume calibrations will be performed to evaluate the appropriate volume of gas to be purged from each probe prior to sample collection. This will be done by performing time-series sampling of at least one (l) probe to evaluate trends in soil gas concentrations as a function of purge volume. Soil gas samples will be analyzed in the field immediately following collection.

Flux Chamber Sampling of Landfill Gas

Flux chamber sampling is planned at eight random locations in Areas 1 and 2. Flux chamber sampling is one of the preferred technologies for direct measurement of volatile species emission rates from subsurface contaminants. The technique uses a surface enclosure (flux chamber) to isolate a known surface area for emission rate measurement (rate per area).

Emissions enter the open bottom of the chamber from the exposed surface. Clean, dry sweep air is added to the chamber at a metered rate. Samples are collected from the exist port to measure the contaminant air concentrations within the chamber. The emission flux is calculated from the isolated surface area, the sweep air flow rate and the emission concentration. Sampling methodology is in accordance with the USEPA protocol entitled "Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber - User's Guide". All samples will be collected using a tedlar bag and analyzed for non-radiological volatile chemicals of concern using USEPA Method T014.

3.11.3 Fugitive Dust Sampling and Analysis

Fugitive dust sampling will occur at non-vegetated areas, and roadways which traverse, or are located along the perimeter of Areas 1 and 2. Sampling will be performed following two to three days of non-rainy weather when the average wind speed is 10 mph. Sampling will be performed approximately 12-inches above the ground surface using a Hi-Vol sampler. Samples will be collected upwind and downwind of Areas 1 and 2. Samples will be analyzed for the complete suite of chemicals of concern (uranium-235 and 238, thorium-230, radium-226, VOCs, SVOCs, TPH, pesticides, PCBs, priority pollutant metals and cyanide).

4.0 SAMPLE PRESERVATION AND SAMPLING DOCUMENTATION

4.1 Sample Preservation, Containers, and Holding Times

Sample preservation, containers, and holding times for each analytical parameter are specified in Table 4-1. Holding times are specified from the time of sample collection. Laboratory cleaned and supplied containers will be used for sample collection. Preservatives will be supplied by the laboratory in the containers and will not be added by the field technician.

4.2 Sample Documentation, Labeling, Packaging and Transportation, and Identification

4.2.1 Sample Documentation

Bound field log books will be maintained by the sampling team. Daily entries will be made in ink.

It is the responsibility of the sampling team leader to ensure that appropriate information is recorded in field log books. Records will contain sufficient information to reconstruct the sampling activity without relying on the collectors's memory. For each sample collected (or set of samples, as appropriate), the field log book will contain:

- Project name;
- Date and time of sample collection;
- Sample location description;
- Sample collection method description (including any calibration, purging, personal protective equipment ("PPE"), etc.);
- Description of sample (matrix, appearance, etc.);
- Analyte(s) of concern;
- Personnel collecting samples;
- Description of environmental conditions;
- Sample treatment, containers, preservation, register numbers, and corresponding chain-of-custody numbers;
- QA/QC sample documentation (e.g., identification numbers and methods); and
- Results of field measurements.

TABLE 4-1

At the end of each day's activities, the sampling team leader will review all of the day's entries for completeness. Following this review, the sampling team leader will initial and date each page. Each day's entries will be photocopied and retained in a separate field file box or in a file at the McLaren/Hart office. This precaution is taken to provide backup should the field log book be lost or destroyed.

Should corrections in the field log book be required, the following guidelines shall be observed:

- A single line shall be drawn through the incorrect information and the corrected statement or information shall be written in the next available space. Both will be initialed and dated by the person making the entry. Notations running along the margins are not acceptable.

- If there is insufficient space to place the correction at the point of the deletion, then a reference shall be provided to the location where the corrected information is presented.

- If a correction is made after the file photocopies have been made, copies of the corrected pages shall be appended to the original file copy.

- Under no circumstances shall "white out" or other correction materials be used.

4.2.2 Sample Identification

Soil, sediment, and groundwater samples will be identified using an appropriate sample register number and a Site-specific sample identification code, both of which are defined below.

A register number is a predetermined, sequential number assigned to each individual sample, linking the sample to descriptive information recorded in the sample register book. The register pre-printed label will be affixed to the sample container and covered with clear plastic tape. Soil and sediment samples will receive register sample numbers from a soil sample register. Groundwater samples will receive register and sample numbers from a water sample register. An example of a water sample register and label and an example of a soil sample register and label is shown in Attachment 7.

A Site-specific sample identification code is an alphanumeric code designed to allow determination of the sample origin, characteristics, and intent. However, such a code should not be so graphic as to allow bias in an analysis. For work at this Site, the register number will also serve as the primary sample identification. This non-descriptive number will provide no source of bias, yet will allow reference to all pertinent sample information in the data base of Site information. In addition, the source location (i.e., MW-1, SB-2, etc. will be annotated in the field log book, and serve as a Site-specific identification code.

4.2.3 Sample Labeling

Sample labeling will be utilized to identify samples to permit the correlation of analytical results with sample location.

All soil, sediment, and groundwater sample labels will be identified by the register number, which is a pre-printed serial number printed on the sample bottle label and matching sample label register page (see Attachment 2). In addition, the following information will be recorded on each label and recorded in the field log book for all samples: (1) project name; (2) sample location (i.e. MW-1, SB-2, etc.); (3) date and time of collection; and (4) sampler's initials.

4.2.4 Sample Packaging and Transportation

Subsequent to sample collection and labeling, sample containers will be packaged securely for shipment to the laboratory. The purpose of sample packaging and transport procedures is to insure that sample bottles arrive unbroken; with adequate preservation; without impact due to melted ice; within the allotted laboratory holding times; in coordination with the analytical laboratory; with proper chain-of-custody documentation; and in accordance with applicable USEPA and Department of Transportation regulations. A sample chain-of-custody form is shown in Attachment 8.

It is the responsibility of the sampling team leader to utilize the following procedures.

- Plastic and glass bottles and jars (except glass volatile organic analyses ("VOA") vials) will be placed in resealable, plastic bags, one bottle per bag. Four glass VOA vials will be utilized per sample. All four glass VOA vials will be placed in one resealable plastic bag;

- Glass containers will be encased in either bubble wrap or foam blocks to prevent containers from touching and thereby reduce the possibility for breakage;

- A thermally insulated cooler lined with a large size plastic bag will be utilized to hold sample containers for transportation to the analytical laboratory;

- All samples (except radionuclide and priority pollutant metal samples) will be placed in a cooler lined with a sufficient quantity of double-bagged ice to maintain samples at or below 4 degrees Celsius; alternatively Blue-Ice may be used in place of ice. Radionuclide and priority pollutant metal samples do not need to be chilled;

- Sample bottles will be placed upright in the cooler and the cooler will be filled with an inert packing material;

- One trip blank will be sent with each shipment (VOC shipments only);

- Completed chain-of-custody documentation will be sealed inside a plastic bag and placed inside the cooler;

- The cap to the cooler drain will be taped shut;

- The cooler will be wrapped with strapping tape at two locations;

- One numbered custody seal will be placed on the front right of the cooler;

- The following checklist will be utilized to verify final packaging:

    (1) The chain-of-custody forms are properly filled out and account for every sample contained in the cooler.

    (2) The samples and documentation being shipped coincide with the information contained in the field log book.

(3) The samples contained in the cooler are destined for the appropriate laboratory and that all similar types of samples are destined for the same laboratory.

(4) There is sufficient ice in the cooler to keep the samples at or below 4 degrees Celsius during shipping and that the ice is appropriately contained.

(5) The samples are securely packed and minimal space remains within the cooler.

(6) The cooler is appropriately addressed, sealed with tape and the appropriate custody seal.

- All samples will be shipped to the appropriate laboratory via overnight courier; and

- The receiving laboratory will be contacted to inform them of the estimated arrival time of the samples.

5.0 DECONTAMINATION PROCEDURES

All sampling equipment will be properly decontaminated prior to use in the field to prevent or minimize cross-contamination between field samples and external sources, and will be cleaned in accordance with the following procedure:

1) Wash and scrub in non-phosphate detergent.
2) Rinse in tap water.
3) Second rinse or soak in tap water.
4) Rinse in distilled/deionized water.
5) Air dry.
6) Wrap in cleaned (decontaminated) aluminum foil, shiny side out.

Sampling equipment will remain in the wrapping material until it is used in the field. All precleaned equipment will be stored in a clean area. Disposable gloves will be worn at all times when handling cleaned sampling equipment. While there is a potential for slight phthalate contamination associated with latex gloves, the potential for contaminating the samples with a variety of compounds is far greater if gloves are not worn. In addition, trip blanks and field blanks are designed to detect any contamination associated with handling the sample or sampling equipment. Care will be taken to avoid placing precleaned equipment near solvents, gasoline, or other equipment and/or materials that may impact the chemical integrity of the sampling equipment.

Sampling equipment that is used repeatedly at different sampling locations will be decontaminated between sampling locations or events. Soil sampling equipment does not need to be decontaminated between soil sample collections at the same depth at a single sample location, because these samples are taken adjacent to each other and represent a single sample.

Decontamination wastewater generated by the decontamination of hand held sampling devices will be placed in a 5-gallon bucket and transferred to 55-gallon Department of Transportation approved drums. A solidly-constructed, plastic lined decontamination pad will be set-up in a centrally located area for the purpose of retaining decontamination water generated from the cleaning of the drilling augers. The augers will be decontaminated using a high pressure, hot-water wash. Water retained in the plastic lined decontamination pad will also be transferred to 55-gallon Department of Transportation approved drums. Drums will be labeled and a drum inventory will be maintained. The inventory and each drum label will contain the following information:

- Drum number;
- Contents and source of contents; and
- Date.

Drum inventory information will be written on the drum labels with indelible ink. Once full, drums will be staged in a secure area of the Site and held pending analytical results.

ATTACHMENT 1

UTILITY CLEARANCE

ATTACHMENT 2

INSTRUMENT CALIBRATION LOG

ATTACHMENT 3

MONITORING LOGS

ATTACHMENT 4

FIELD SOIL DRILLING LOG AND WELL COMPLETION LOG

ATTACHMENT 5

WELL DEVELOPMENT LOG

ATTACHMENT 6

SLUG TEST RECORD

ATTACHMENT 7

WATER AND SOIL SAMPLE LABEL REGISTER

ATTACHMENT 8

CHAIN-OF-CUSTODY FORM